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ASTRONOMY ON THE PACIFIC COAST.*

PROFESSOR RUSSELL TRACY CRAWFORD.

This subject brings instantly to the mind's eye the Lick Observatory on Mount Hamilton, and the Solar Observatory on Mount Wilson, as they are two of the greatest astronomical observatories in the world, and probably the best generally known of all. The one is an asset of the Pacific coast, probably accidentally, the other was placed there as a result of mature deliberation after thorough investigation of many locations. In addition to these two wonderful institutions there is in process of construction a third great observatory near Victoria, B. C., which, when completed, will contain the second largest reflecting telescope in the world. It is evident, therefore, that conditions on this coast are extremely favorable for developing the practical side of astronomy. On the other hand, the theoretical side of the subject is by no means to be lost sight of, as I shall point out.

In the early days before the erection of the Lick Observatory, the only astronomical work on the Pacific Coast was that done by the U. S. Coast and Geodetic Survey under the able direction of the late Professor George Davidson. This was not astronomical work as such, but merely the solving of such astronomical practical problems as were incident to the regular work of the survey. The first real scientific astronomical investigations came with the advent of the Lick Observatory.

This institution is the gift of James Lick, a California pioneer, who had amassed a fortune of several million dollars.

On July 16, 1874, he executed a deed of trust which devoted the entire sum to public purposes.

Among the provisions of the deed is one that directed the trustees

to expend the sum of seven hundred thousand dollars for the purpose of constructing ... a powerful telescope, superior to and more powerful than any telescope ever yet made, with all the machinery appertaining thereto.....

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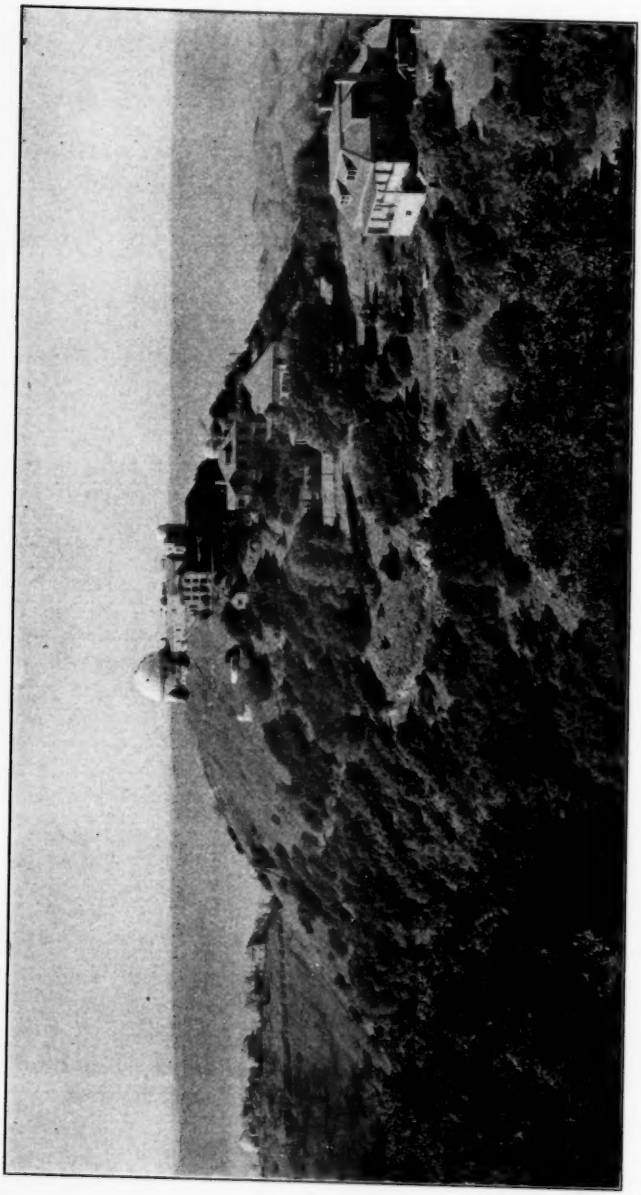


LICK OBSERVATORY FROM THE EAST.

He left the trustees certain discretionary powers as to its location with the proviso, however, that "the same must be located within the state of California."

Just why Lick provided for this telescope and observatory will probably never be known. While I can not recall my authority, I have a very distinct recollection of having heard it stated that the idea was first suggested to him and frequently urged upon him by Professor George Davidson. Concerning this point, however, the director of the Lick Observatory writes,*

> The question, "What induced Lick to provide for a great telescope?" has never been satisfactorily answered; but there is no reason to doubt that he came to this determination without conscious suggestion from others.

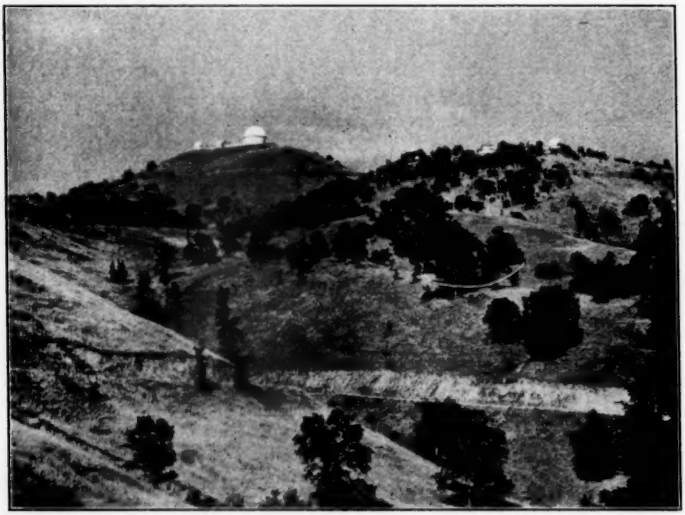
After having several sites tested the trustees decided upon Mount Hamilton, California, as the best location for the observatory. Active work was begun in 1879, and the observatory was completed and ready for regular work in 1888. The plant cost all but $90,000 of the amount set aside for it. The observatory and this balance were turned over to the regents of the University of California by the trustees June 1, 1888; and since then it has been an integral part of the university.

The principal instruments of this observatory are the great 36-inch refractor, a 6-inch Repsold meridian circle, provided by the Lick Trust, and the 36¼-inch reflector, a gift from Edward Crossley, Esq., of England. Besides these there is a host of smaller instruments and auxiliary apparatus. I can not go into details here concerning the instruments, but I wish to mention one which has an important bearing upon the subject of this article. It is that the magnifying power of the great refractor may be made to be as much as 3,000 diameters. When one considers that everything in the line of sight of the telescope is magnified by this amount, it becomes evident that, to be efficient, the telescope must be located at a site where the atmosphere through which the line of sight passes is extremely steady, for any little atmospheric disturbance will be magnified to this amount and destroy what is called the "seeing," giving a poorly defined image of the star or object under observation. And it is principally on account of the splendid atmospheric conditions on the Pacific coast, especially on some of the moderately high mountains, which make *excellent* "seeing" possible, that observational astronomy here has been able to make such tremendous strides.

For the efficient use of a great telescope its location must be in a region of great atmospheric calm, where the sky is clear and transpar-

* "A Brief Account of the Lick Observatory of the University of California," prepared by the Director of the Observatory. Fourth edition, 1914.

ent, with little wind, and where the number of days and nights of a year during which such conditions do not exist is small. For some reason the "seeing" conditions at Mount Hamilton during the day are not of the best; but at night excellent conditions are found on a large majority of the nights of a year, and many nights yield "seeing" that



LICK OBSERVATORY FROM THE WEST

might be considered perfect. A glance at the illustrations showing the mountain as seen from the east and from the west will make it evident at once why these conditions obtain. With the exception of a saddle running eastward, the land slopes away rapidly from the summit down into deep valleys, so that there is but little opportunity for heat waves radiated from surrounding land to mount to the atmosphere above the observatory and create atmospheric disturbances. The mountain is not so very high (4,209 feet above mean sea level), but it is high enough to hold the observatory in an atmosphere free from dust, smoke and fog. Being near the ocean, fogs are very frequent at certain seasons over the valleys in this region. It is seldom, however, that they mount high enough to envelop the observatory. Many evenings and early mornings fog completely fills the surrounding valleys, so that the observatory seems to rest on an island in a vast sea of fog. Often peaks only a few hundred feet lower than Mount Hamilton are covered by the fog, yet the work with the great instruments is uninterrupted. The picture "Fog in the Valleys at Sunset" gives a better idea of this con-

dition than I can describe. In such a location as this the 36-inch refractor can be used with its maximum power a large portion of the time. In less favorable localities even larger instruments would not be so efficient.

It is one thing to have an excellent plant, and it is another thing to have men skillful enough to operate such a plant effectively. A very proficient marksman can not do very much damage with a blunderbuss, and one unskilled will not be able to produce any good results from the best modern artillery; but an expert behind a Krupp can produce a high percentage of effective hits. And so it is with the Lick Observatory. Not only is it a wonderful engine of science, but also it has been very fortunate in the astronomers who have operated it.

I can not here go into the details of all that has been done at the Lick Observatory, but the following extracts from "A Brief Account of the Lick Observatory of the University of California," prepared by the director of the observatory, 1914, give an idea of the principal things of general interest that have been accomplished in the quarter of a century of its existence:

1. To the four bright satellites of Jupiter discovered by Galileo in 1610, the Lick Observatory has added four satellites.

2. Twenty-nine comets have been discovered. Nineteen of these were unexpected, and ten were periodic comets whose return had been predicted.

FOG IN THE VALLEYS AT SUNSET, MT. HAMILTON.

3. The first great success in photographing comets and the Milky Way were made here.

4. About 4,400 double star systems have been discovered.

5. Irregularities in the motions of the first magnitude star *Procyon* had led the celebrated German astronomer Bessel, three quarters of a century ago to predict that *Procyon* had a companion sun revolving around it. This companion was discovered with the Lick telescope.

6 Spectrographic observations of stellar motions have shown that the solar system is traveling through space, with reference to the general stellar system, at a speed of about twelve miles per second.

7. The Mount Hamilton and Santiago* spectographic observations of stellar motions have shown that the stars effectively young are traveling slowly, middle-aged stars more rapidly, and old stars more rapidly still; that is, that the velocities of the stars increase with their effective ages.

8. Observations have established that those nebulæ known as planetary nebulæ are traveling through space with average speeds even higher than the average speeds of the stars. It had previously been supposed that these nebulæ represented a stage of existence antecedent to the stellar age. The high velocities of these objects have created the opinion that they have more probably been formed from stars which have been overtaken by catastrophes, such as collisions with the other celestial objects.

9. The North Pole Star was found to be a triple star, in 1899, by means of spectrographic observations. The first magnitude star *Capella* was discovered to consist of two stars revolving around their center of mass in 104.1 days, the two nearly equal components being inseparable in our largest telescopes.

10. In the same manner about 250 spectroscopic binary stars have been found at Mount Hamilton and Santiago.

11. A study of the orbits of spectroscopic binary stars has established that the component stars in a system whose spectrum indicates early age are relatively very close together, requiring very short periods of revolution, and that the orbits are nearly circular. In systems whose spectra show them to be of greater effective ages, the distances separating the components are successively greater, on the average, and their orbits are more eccentric. The observed facts on the subject are fully confirmative of existing mathematical theories of the evolution of double star systems.

12. The Crossley reflecting telescope established for the first time the tremendous advantage of this form of telescope in the photography of certain classes of celestial objects, such as nebulæ, star clusters, etc.

13. Before the Crossley reflector was in use about 10,000 nebulæ had been discovered at various observatories. A few dozens of these were known to be spiral in form. The Crossley photographs led to the discovery of many hundreds of additional nebulæ in the extremely small part of the sky covered by the photographs. It was a simple matter to calculate that certainly 120,000 and possibly half a million nebulæ await discovery whenever time can be spared for the Crossley reflector to undertake this work. These photographs led to the unexpected discovery that a majority of the nebulae are of spiral form—undoubted evidence of their rotation.

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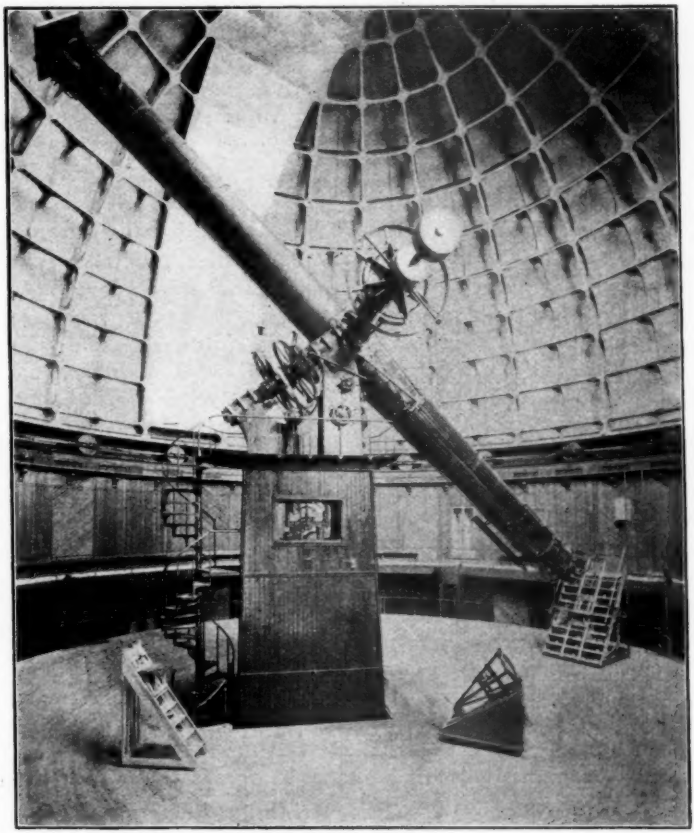
* Santiago, Chile, is the location of the D. O. Mills Observatory, which is administered by the director of the Lick Observatory.

14. The extensive series of photographs of the minor planet *Eros* and surrounding stars, with the Crossley reflector, led to a new and accurate determination of the distance from the earth to the sun.

15. Eight total solar eclipses have been successfully observed by expeditions whose expenses were defrayed by friends of the observatory.

16. It has been shown that the new stars appearing in recent years have been converted into nebulæ, and later, in many cases, into extremely faint stars of apparently normal condition.



THE 36-INCH REFRACTOR OF THE LICK OBSERVATORY.

17. Many thousands of extremely accurate positions of the stars have been secured with the meridian circle.

18. Very extensive observations of double stars, comets, planets, and satellites have been made.

19. A large number of orbits have been computed for visual double stars.

spectroscopic binary stars, comets, and asteroids.

20. Extensive additions have been made to our knowledge of the spectra of nebulæ, comets, new stars, and stars of special interest.

21. Important studies of the spectra of spiral nebulæ and star clusters have been inaugurated.

22. An atlas of the moon was made in the first year of the observatory's existence, on the basis of photographs obtained with the large telescope.

23. The motions of approach and recession of about 1,500 naked-eye stars, distributed over the entire sky, have been observed with the 36-inch refractor at Mount Hamilton and the D. O. Mills reflector at Santiago.

24. Spectroscopic observations at Mount Hamilton and on the summit of Mount Whitney have shown that the atmosphere of *Mars* is of low density, probably much less dense at the surface of *Mars* than the earth's atmosphere is at the summit of the highest peak in the Himalaya Mountains. These observations have established likewise that the quantity of water vapor in the atmosphere of *Mars* above, say, a square mile of its surface, must be very slight as compared with the quantity of water vapor in the earth's atmosphere above an equal area.

The wise economical policy of this observatory is to engage principally in those investigations which cannot be carried on with smaller and less effective instruments. Much that could be done there is left to smaller institutions. The great instruments are used only for the problems that demand their great power. And these are quite sufficient to keep them in constant use.

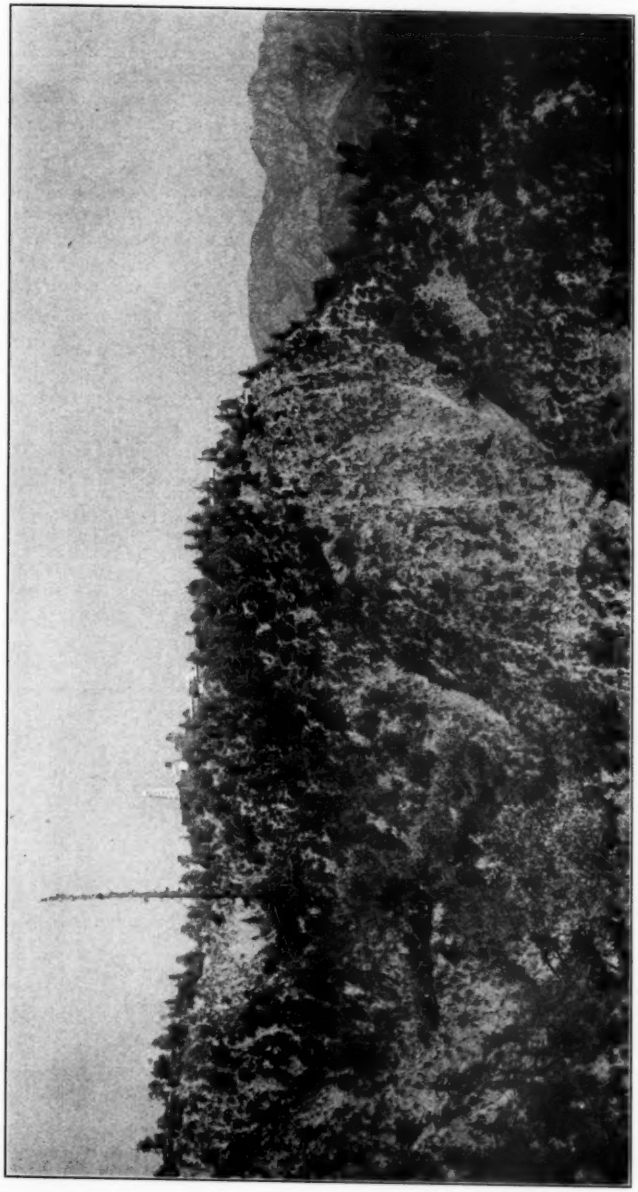
Turning now to the Mount Wilson Solar Observatory we find a unique institution. As its name implies, it is an observatory erected primarily for the study of the sun.

In 1902, Dr. S. P. Langley addressed a communication to the Carnegie Institution recommending the establishment of an observatory at a very high altitude for the special purpose of measuring the solar radiation.

This recommendation resulted ultimately in the erection of the Solar Observatory by the Carnegie Institution by which it is supported. Various sites in Arizona and in southern California were tested, and the summit of Mount Wilson (nearly 6,000 feet above sea-level) near Pasadena in southern California was selected. In the choice of a site for this observatory excellent "seeing" conditions in day time as well as at night were of primary importance. Such conditions were found to exist on Mount Wilson.

For director of the observatory a very wise choice was made in Dr. George E. Hale. It is due principally to his genius and untiring efforts that this wonderful plant has been designed and brought to its present high state.

Dr. Hale points out that the term "solar observatory" is to be used in a broad sense,



MOUNT WILSON SOLAR OBSERVATORY.

since it is not intended to exclude from the program certain investigations of stars which are of fundamental importance in any general study of the problem of stellar evolution. For the sun is a star, comparable in almost every respect with many other stars in the heavens, and rendering possible, through an intimate knowledge of its own phenomena, the solution of some of the most puzzling questions in the general problem of stellar evolution. Conversely, however, the stars are suns, and if we would know the past and future conditions of the sun, we must examine into the physical condition of stars which represent earlier and later stages of development. It will be seen that there is ample ground for the inclusion in the equipment of a solar observatory of certain instruments especially designed for the study of stellar problems.

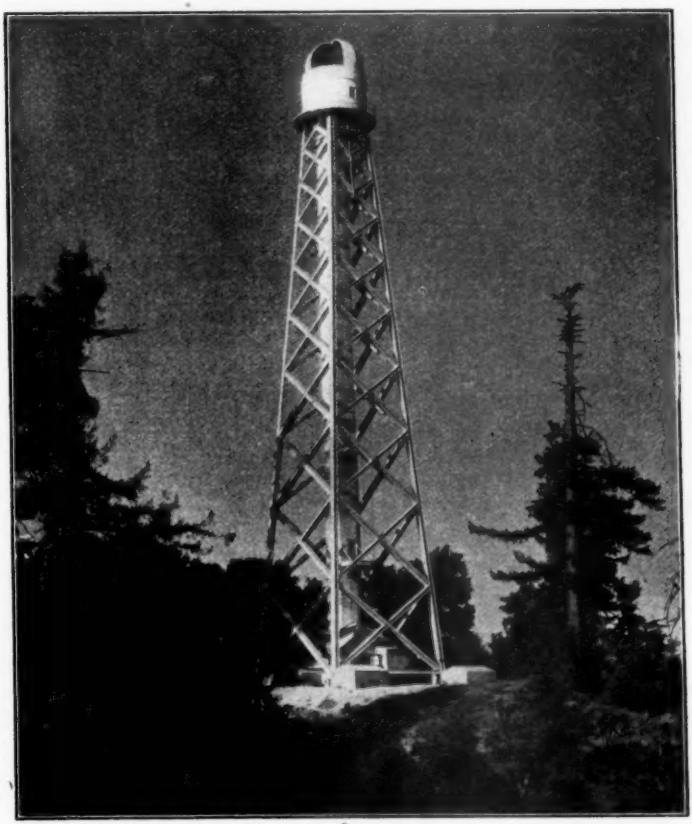
Such an observatory, whose primary object is "to apply new instruments and methods of research in a study of the physical elements of the problem of stellar evolution," must of necessity have as complementary parts of its equipment a physical laboratory and an adequate machine shop. These two parts have been supplied and are located in Pasadena. Here not only are smaller pieces of apparatus made and repaired, but also the enormous discs of glass for the 60-inch and the 100-inch reflectors have been figured and tested.

The instrumental equipment of the solar observatory is naturally very complete. In addition to the numerous smaller pieces of apparatus there may be mentioned in particular the Snow telescope, the two tower telescopes, and the monster reflectors.

The Snow telescope consists of two 24-inch concave mirrors of different focal lengths (when either one is in use the other is easily put out of the way) mounted well above the ground in such a way as to throw the sun's rays horizontally under a louvre covering to the spectroscope or other apparatus, where they are analyzed. Soon after this instrument was in operation Dr. Hale conceived the idea of mounting the cœlostat at the top of a tower, and sending the rays vertically downward to the spectroscope so as "to avoid disturbance of definition caused by heated currents of air arising from the ground." He therefore had designed and erected a 65-foot tower for this purpose. This was very successful. Then desiring a greater focal length than could be obtained with this height, he had built a second tower 150 feet high. Under this tower a well was excavated to the depth of nearly 80 feet, thus providing for a possible focal length of about 230 feet. The 150-foot tower is of ingenious construction. It is a tower within a tower. The main structure which supports the cœlostat at the top is completely sheathed in an encasing tower which supports the dome, so that there is complete protection from the wind. When one looks at the tower he sees only the framework of the sheathing. This great tower telescope is a most efficient and satisfactory instrument.

There is no larger telescope in operation today than the 60-inch

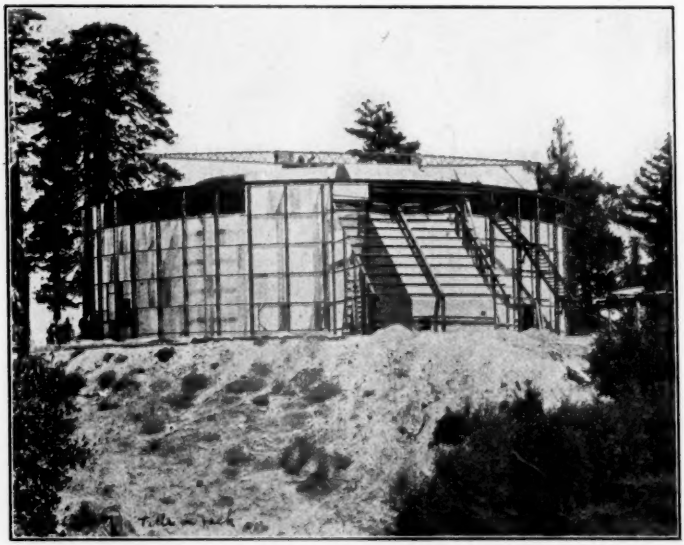
reflector, the reflecting surface of which was ground by Mr. Ritchey in the shop at Pasadena. The remarkable photographs of nebulæ that have been made with it speak loudly in praise of its efficiency. This instrument is soon to be supplanted in its proud position of size by the 100-inch reflector, the gift of Mr. J. D. Hooker, which is nearing completion. The figuring of the enormous block of glass has also been done by Mr. Ritchey. The present state of the building to hold this great reflector is shown in the accompanying picture. The completion of this, the largest telescope in the world, will undoubtedly mark an epoch in observational astronomy. Its light-gathering power will be nearly three times as great as that of the 60-inch, and more than seven times that of the Crossley reflector of the Lick Observatory, which in



THE 150-FOOT TOWER, MOUNT WILSON SOLAR OBSERVATORY.

its turn fifteen years ago marked an epoch. If "half a million nebulæ await discovery" with the Crossley, think of the possibilities awaiting this giant!

In the ten years of its existence the results of the investigations of the Mount Wilson Solar Observatory have been very numerous and most valuable. I have not space here even to enumerate them. Every annual report of the director contains a summary of the principal results of the year. The number of such results is noticed to increase from year to year. In the last Annual Report (1913) seventy-two results are summarized. Most of these are of such a technical nature that they are of interest only to the scientist. Of the results of general interest I may mention the discovery of magnetic fields in sunspots; the fact that "the sun is a magnet, with magnetic poles at or near the poles of rotation"; "the polarity of the sun corresponds with



PRESENT STATE OF BUILDING FOR HOUSING THE 100-INCH REFLECTOR, MOUNT WILSON SOLAR OBSERVATORY.

that of the earth—a conclusion which may prove to have an important bearing on theories of terrestrial magnetism"; "the evidence that has been amassed in support of the view that light is absorbed in space." The last, as Dr. Hale points out

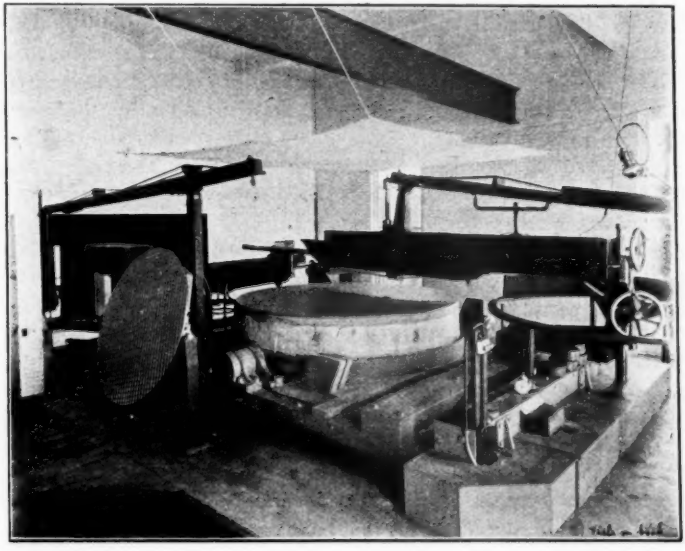
> not only offers an explanation of otherwise obscure phenomena, but promises to give what appears to be the only possible method of measuring the most profound depths of the universe.

The investigations of the solar observatory are carried on not only by the regular staff, but also by other scientists who are invited to make use of the wonderful equipment there.

The Lick and the Mount Wilson Solar Observatories are the only ones at present on the Pacific coast whose energies are devoted wholly to investigations. A third will soon be in operation. This is to be an observatory eight miles north of Victoria, B. C. to house the 72-inch reflector of the Canadian government. Dr. Plaskett says:

> Word has been received from Paris that the disc for the mirror is ready for shipment and there is every prospect of the telescope being ready for erection next year.

This was written in June 1914. A later report tells us that the disc has been received at Allegheny, and that work upon the mirror has been begun. When completed this will be the second largest reflector in the world.



THE GLASS DISK FOR THE 100-INCH MIRROR IN THE PASADENA LABORATORY OF THE MOUNT WILSON SOLAR OBSERVATORY.

In addition to these there are on the Pacific coast several small observatories connected with educational institutions whose principal use is to supplement by practical work the instruction in astronomy in these institutions. Among these may be mentioned the observatories of Pomona College, of Santa Clara College, Chabot Observatory of the

Oakland High School (the Chabot Observatory is soon to be supplied with a 20-inch refractor), University of Washington, and the Students' Observatory of the University of California. Besides these there is a small government observatory, a branch of the U. S. Naval Observatory, located at the naval station on Mare Island, used principally for time service and the regulation of the chronometers of the ships of the Navy. Finally, there are a few small private observatories wherein some amateur astronomers delight to "follow the courses of the stars."

Theoretical as well as practical astronomy is well fostered on the Pacific coast. Its chief development is to be found in the Berkeley Astronomical Department of the University of California. Here has been organized a thorough school of astronomy, than which, according to the late Professor Simon Newcomb, there is none better. Not only is the science taught at Berkeley, but also theoretical investigations are continually being carried on.

It is only natural that in a region possessed of such institutions as I have mentioned there should be a considerable interest in astronomy among the people. This interest is manifested principally through an organization known as the Astronomical Society of the Pacific with headquarters in San Francisco. This society resulted from the interest taken by a group of amateur astronomers and photographers in the total eclipse of the sun visible in California, January 1, 1889. It has a membership of several hundred who are interested in a general way in the science of astronomy. In addition to its meetings the Society issues bi-monthly its Publications of the Astronomical Society of the Pacific. The Society has been given two funds the interest from which is to be devoted to giving certain medals. One of these is known as the Donohue Comet Medal. One such medal is awarded to every discover of a new comet. The other is the Bruce Gold Medal, and is looked upon as one of the most important medals that can be awarded to an astronomer. It is awarded "for distinguished services to astronomy." The medal itself is a beautiful work of art, and is valuable both intrinsically and for what it symbolizes. The great value that astronomers attribute to this medal can be appreciated better when the manner of making the award is understood. The process is as follows: The directors of six observatories (Harvard, Yerkes, Lick, Berlin, Paris, and Greenwich) are each requested to nominate three men worthy to receive the medal in any given year. After these nominations are in it is usually found that six or seven names are presented to the directors of the Society from which then their choice for the medal *must* be made. If an award is made, therefore, it is to some one nominated by one or more (usually more) of the directors of six of the leading observatories of the world. There can be no doubt then that the recipient

is justly entitled to this medal "for distinguished services to astronomy." That it is most highly prized by its recipients I quote from a typical letter of acceptance of the medal. The medalist writes, "I regard this distinction as the highest an astronomer can receive. . . ."

The results of the investigations at the Lick Observatory are issued in the Bulletins of the Lick Observatory for short articles, and in the Publications of the Lick Observatory (Volume XII, just issued) for the more extended work. Results from the Berkeley astronomical department are also issued in the Bulletins of the Lick Observatory, and one volume (VII) of the Publications of the Lick Observatory is devoted to its investigations.

The Contributions from the Solar Observatory, Mount Wilson, California, issued by the Carnegie Institution of Washington, give to the world the results of the investigations carried on at the observatory on Mount Wilson and in the laboratories in Pasadena.

The Publications of the Astronomical Society of the Pacific I have already mentioned. The list of astronomical publications on the Pacific coast is made complete, I think, when I mention finally the Publication of the Astronomical Society of Pomona College, an interesting quarterly popular magazine issued by the astronomical students of Pomona College.

In preparing this account of astronomy on the Pacific coast I have drawn freely from "A Brief Account of the Lick Observatory" (fourth edition), and from the annual reports of the director of the Mount Wilson Solar Observatory. In conclusion I wish to express my thanks to the directors of these two observatories for their kindness in providing the illustrations.

GRAPHICAL ILLUSTRATION OF STELLAR PARALLAXES.

FREDERICK SLOCUM.

The publication of the accompanying diagrams was suggested by a discussion carried on in *The English Mechanic* about a year ago. In that discussion some of the correspondents expressed doubt as to the reality of any determinations of stellar parallaxes.

In the *Astronomische Nachrichten*, Vol. 199, p. 18, Mr. Walkey refers to the "Inherent uncertainty of all measured parallaxes." And in POPULAR ASTRONOMY, Vol. XXII, p. 542, Mr. Thomas writes "I do not think we can trust at all any parallax less than 0″.05, and, strictly speaking no parallax below 0″.10 can be regarded as anything but the merest approximation, and all below 0″.30 as probably only a rough approximation to the truth."

It is true that in lists of published parallaxes the results for individual stars are frequently very discordant. For example, for Sirius they range from +0″.16 to +0″.51, and for 61 Cygni the range is nearly as great. It is possible that the ideas of those quoted above are based upon some such lists, but it must be remembered that many of the results were obtained years ago with small instruments and by methods now antiquated. That their statements do not apply to the modern parallaxes obtained from photographs taken with the larger instruments is evident to all who have examined the results and are able to interpret "residuals" and "probable errors".

For those who are not accustomed to judge the results of observations by these criteria, the graphical representation will undoubtedly be more convincing. I give, therefore, the results from five series of plates taken with the 40-inch refractor of the Yerkes Observatory, selected to show the possibilities of the photographic method as used with that instrument.

The stars chosen range from the fourth to the tenth magnitude, and their computed parallaxes from +0″.01 to +0″.26. The details of the exposure and measurement of the plates and the method of reduction are explained by Schlesinger in the *Astrophysical Journal*, Vols. 32, 33 and 34, and by Slocum and Mitchell in the *Astrophysical Journal*, Vol. 38 p. 1.

It is sufficient to say here that several photographs of the star to be studied are taken at intervals of approximately six months. The position of the star, with respect to from three to eight fainter stars on each of these plates, is measured and the relative displacement of the star

due to proper motion and parallax is obtained. Before attempting to compute from these displacements, by a least square solution, the separate proper motion and parallax, it has been my custom to plot the results of the measures on coördinate paper.

The upper curve of Figure I is a typical example. The abscissae are days, the ordinates divisions of the scale of the measuring machine. One division of the scale corresponds to 2″.66, so that one square on the diagram equals 0″.0266

The general inclination of the broken line indicates proper motion in right ascension, since the measures are made in that coördinate only. The periodic zigzag effect is due to parallax. This is brought out more clearly in the lower curve, in which the observations are approximately corrected for proper motion. In all the subsequent figures the observations have been similarly corrected.

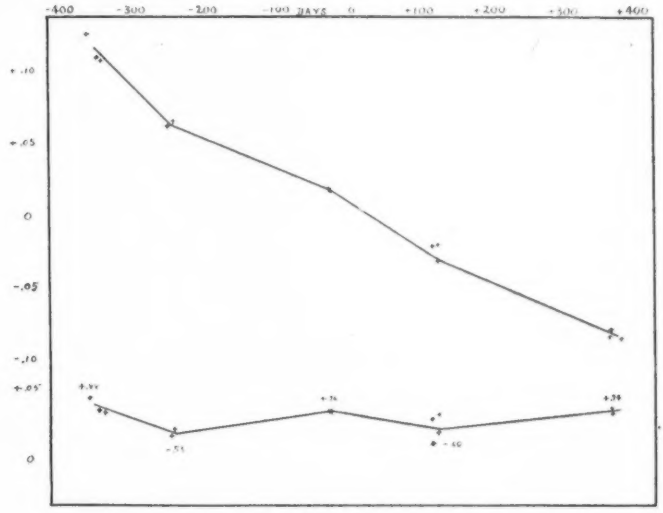


FIGURE I

Oxford + 25°.46692 ($16^h\ 0^m$, +25° 39′)
Vertical scale: 1 inch = ″.117 $\pi = +\ 0''.053 \pm 0''.009$
Upper curve shows proper motion and parallax, lower curve parallax only.

The results in Figure I are from observations of star No. 46692 in the Oxford photographic zone of declination +25°. In the B.D. catalogue it is +25°3020. It is of magnitude 7.5 and has a total proper motion of 0″.922, of which 0″.523, the component parallel to the equator, appears in the upper curve. Thirteen plates were secured, three at the first epoch, two at the second, one at the third, four at the fourth, and three at the fifth, as shown by the crosses on the diagram. If the

observations were made alternately when the star is six hours east and six hours west of the sun, the maximum displacement due to parallax would be obtained. This is rarely possible and the figures over each group of points, in the lower curve of Figure I, indicate how nearly the condition was fulfilled in this case. At the first epoch the star was displaced .88 of its maximum amount in the positive direction, at the second epoch .53 in the negative direction, +.96 at the third, etc. The periodic zigzag of the line shows that the star has an appreciable parallax relative to the fainter comparison stars. The reduction of the observations gives +0″.053 for its amount.

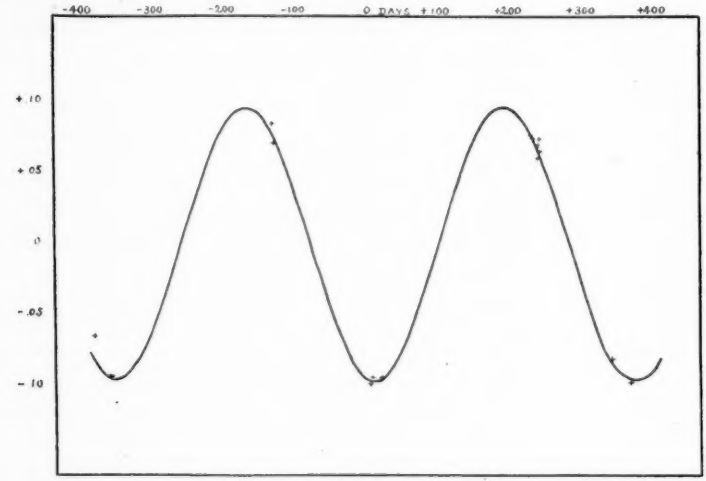


FIGURE II

61¹ Cygni ($21^h\ 2^m$ +38° 15′)
$\pi = +\ 0''.267 \pm 0''.004$
Vertical scale: 1 inch = ″.117

In Figure II, instead of simply connecting the groups of points by straight lines, the actual sine curve corresponding to the computed parallactic displacement is shown, and the fact that the individual results are very consistent is indicated by the way in which the points fit the curve. The scale is the same, as in Figure I, so it is evident that this star has a very large parallax. The solution from fourteen plates gives +0″.267. This is for the preceding component of the double star 61 Cygni, of great historic interest as the first star to yield an appreciable parallax. It was determined by Bessel in 1838.

Figure III is drawn for the two components of the double star θ Persei. Curve I is for the primary star, which is of magnitude 4.2, and curve II is for its tenth magnitude companion. Two series of

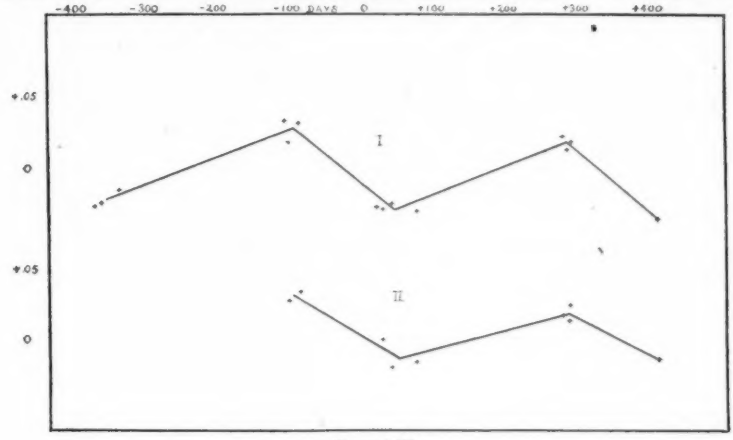


FIGURE III

I θ Persei ($2^h\ 37^m$, $+48°\ 48'$) $\pi = +\ 0''.083 \pm 0''.004$
II θ Persei (companion) $\pi = +\ 0''.071 \pm 0''.004$
Vertical scale: 1 inch = ″.097

plates were taken. In the first an occulting disk was used to reduce the light of the primary star, so that its image on the plate is about the size of the images of the comparison stars. This device greatly increases the accuracy of measurement of the brighter star, but it also

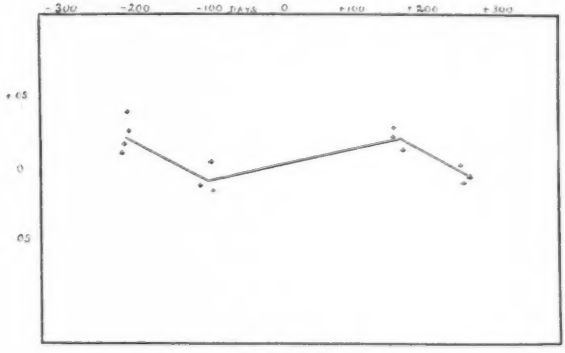


FIGURE IV
42 Comae Berenices ($13^h\ 5^m$, $+18°\ 3'$)
$\pi = +\ 0''.058 \pm 0''.008$
Vertical scale: 1 inch = ″.117

reduces the light of the companion, so that it does not appear on the plates. For the parallax of the companion, therefore, a second series of plates was taken with the occulting device removed. The results are shown in curve II. Both curves show clearly the periodic displacement due to parallax. From the computations the values are $+0''.083$ for the primary, and $+0''.071$ for the companion.

Figure IV gives the curve for another well-known double star, 42 Comae Berenices. The components are of equal magnitude, 5.2, and always less than $1''.0$ apart. On the plates the two images blend together, and the settings had to be made on the slightly elongated composite image. This, naturally, made the measures less accurate, and the fact that the points are somewhat widely scattered indicates that they are less consistent than some of the preceding. Nevertheless the existence of a real parallax is evident. Its value is $+0''.058$.

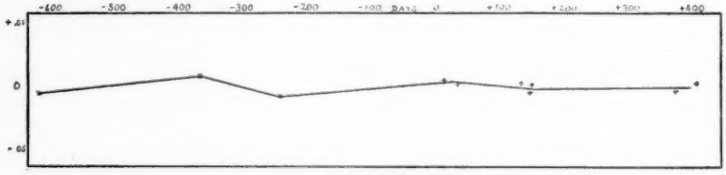


FIGURE V
Anonymous ($11^h\ 6^m$, $+\ 6°\ 59'$)
$\pi = +\ 0''.010 \pm 0''.004$
Vertical scale: 1 inch = $''.117$

The curve in Figure V is for a star of magnitude 9.5 discovered by Wolf to have a proper motion of nearly $1''.0$ per year. It is star No. 4 in his list published in the *Astronomische Nachrichten*, Vol. 171 p. 327. Its parallax comes out much smaller than would naturally be expected for a star with such a rapid motion. The solution gives $+0''.01$, but that this value, small as it is, is not wholly fictitious is indicated by the small but unmistakable periodicity in the curve.

From an examination of these curves, which are simply samples of what may be done with the 40-inch refractor under fair conditions, it is evident that parallaxes of the order of $0''.05$ stand out conspicuously from the measures, and the approximate amount of the parallax may be estimated before the solution of the equations is begun, and even when the relative parallax is no greater than $+0''.01$, its existence can frequently be detected in the graph of the measures.

Middletown, Conn. Mar. 13, 1915.

THE SPELL OF THE SOUTHERN STARS.

ADA WILSON TROWBRIDGE.

"This heaven
Made beauteous by so many luminaries,
From the deep spirit that moves its circling sphere,
Its image takes, an impress as a seal."

DANTE.

To-day in our mad struggle for material things, we have lost the stars. That mysterious influence which has been an inspiration to simpler lives does not move us. Among the thousands who enjoy the night, there are but few watchers of the stars; among those who would find peace, few seek it in the vast harmony of rising and setting constellations. And yet nothing in the visible Universe has exerted such a powerful influence upon the imagination of man. The movements of the sun, moon, planets, and stars have quickened every emotion from worship to fear, setting men to build altars, to plant and harvest their crops, to prepare for war, to make ready their boats, and to dream out science and poetry. It is quite true that science has made us sophisticated, and we no longer look upon the heavens with naive wonder or fear. The labyrinth of imagery traced for us among the stars has become classic, and we are robbed of some byways of adventure. But a greater perspective is ours for spiritual and imaginative adventure. We approach the vast mystery of the Universe with the telescope, with photography, with the spectrum, and with every aid known to modern science, and we dare to hope for mightier revelations of cosmic harmony and man's relation to the great whole.

There is magic in certain latitudes, and when we think of parallels 24 and 31 as the boundaries of Florida, we bring some of the romance of Benares, Mecca, and Thebes into a winter at Palm Beach, Tampa, or Saint Augustine. None of the Mediterranean Countries of Europe lie so far south as even the northernmost part of Florida. Greece, Italy, Spain, the Holy Land, and almost all of Persia lie north of the parallel 31, which marks Florida's northern boundary. The sweep of the heavens at Alexandria, Egypt, where under Ptolemy so much astronomical investigation was carried on, is about that of Tampa.

Tourists in the south invariably exclaim "How wonderful the stars are down here!" but few realize what it is that causes this appearance of unusual beauty and grandeur. Conditions of the atmosphere make the stars seem strangely near and brilliant, and a new viewpoint with

reference to latitude gives an unaccustomed semblance to familiar star groups; the moon floats near the zenith, Orion and Scorpio ride amazingly high, and the Big Dipper may be quite out of sight. But the chief reason for this new wonder in the heavens is the presence of some surpassingly beautiful and brilliant stars belonging to constellations of the southern hemisphere which are not visible in the north. Centaurus, Argo, Eridanus, and Crux all display glorious first magnitude stars, as well as many of the second magnitude, so distributed and grouped as to at once attract attention; and the little constellations of Phoenix, Grus, and Ara with a scattering of paler stars, complete the striking circle about the southern Pole.

In the West Indies and from some places in Florida all the twenty brightest stars of the heavens are visible. One is far enough south to see Canopus, Achernar, Alpha and Beta Centauri, and Alpha Crucis, but not near enough to the equator to lose Capella or Vega. It is impossible to describe the feeling of spiritual wealth which comes to one when realizing that in the passage of a few months all these splendid objects will move majestically before him. It seems to give one a grasp of the Universe from pole to pole, and to put him in touch with the law and harmony of uttermost space.

It is clear that the stars nearest to the South Pole can be seen but for a short time each night as the visible arcs of their courses are short. Thus, the most satisfactory time for observing them is when they are on the meridian, that is, when they have reached the highest point touched in the daily course over the heavens. This period when the star is visible, long or short according to the distance from the South Pole, will occur during the early hours of the evening for a part of the year, and during the hours from midnight to dawn for some of the months. The time most alluring for watching the stars will be established, largely, through one's temperament and the degree of enthusiasm one feels for contemplation of the heavens. For me there is no time, particularly in Florida, so bewitching as that between two o'clock and dawn. Whether in the full flood of moonlight, or in the dark of the moon, no hours seem so saturated with eternal beauty and peace as these, and at no time are the heavens so intense, so mysterious, and so enkindling to the imagination.

THE SOUTHERN CROSS.

"Through divers passages, the world's bright lamp
Rises to mortals, but through that which joins
Four circles with the threefold cross
In happiest constellation set He comes.....
And whiteness hath o'erspread that hemisphere."

DANTE.

Divinity certainly set its mark on the heavens in the shining emblem of the Southern Cross. With the outline of a cross distinctly traced, sparkling with gleams of orange, white, and red, and compressed to the measure of only about 6 degrees, it stands out among other constellations like some mystic symbol. The Cross is almost perpendicular when it passes the meridian, which adds to the impression that its placement was a conscious token or sign. And certainly this has been the interpretation of both civilized peoples and wild tribes, for it has been looked upon with superstition whether regarded as an omen of good or a portent of awe.

The Southern Cross is said to have been made into a constellation about the year 1679 but it was known and described long before this, and although regarded as a part of Centaurus, popular fancy often isolated the four bright stars that put such a conspicuous mark on the heavens. Many old names, whatever the origin, have reference to the cross-like form, whether the similarity was suggested by the Roman cross, the generative emblem of Shiva and other symbols of phallic worship, or the prehistoric fylfot. In India before the Christian Era there appears to be mention of Crux as "the Beam of Crucifixion" or the "Beam of Torture," the name having reference to the form of the constellation, which was that of the Roman cross, a known symbol of torture and crucfixion. After the Christian Era, the Cross slipped harmoniously and poetically into myths of the new religion. Spanish and Portuguese zealots, inspired to plant their faith in new lands, attached great sentiment to the Southern Cross, regarding it as a sign of Divine approval set upon the heavens. South America, indeed, has been called "the Land of the Holy Cross." And so, invested with such legendary glamour, it is not strange that a certain esoteric beauty, belonging to romance and poetry, should be associated with this precious little group of stars.

Crux is situated a little to the west of Alpha and Beta Centauri, and the figure is composed of five stars, although many other naked-eye stars are included within the constellation. Alpha, the foot of the cross, is a beautiful star of the first magnitude, white in color, but tinged with a warmth of red gold, especially at rising; Beta, clear white, is but little below Alpha in brightness although ranked as a second magnitude star, and lends opulence to the asterism; Delta is white and of the third magnitude, and with Beta marks the cross-bar; Gamma, at the head of the Cross, is a beautiful orange-colored, second magnitude star, and is about 6 degrees from Alpha. The little fourth magnitude star, Epsilon, between Alpha and Delta, is very red, and by its color must have given the impression to the unscientific observer of a much brighter star, for old records of travelers and explorers contain reference to five bright

stars and comment relating to the colors displayed in the Cross. A sixth magnitude star, Kappa, is buried in a cluster of red stars, and paler ones of other hues, but this sight can only be seen with a good telescope, and so could not have added luster to the constellation for the early explorers.

The Southern Cross is visible at Key West and as far north as latitude 27 degrees. It culminates about the 13th of May, and can be seen above a fringe of cocoanut palm, or skimming the vine-draped wall of some old Spanish garden. Most beautiful is it when the watcher, seated on the white, coral sand of some islet, sees it rise out of the warm, twilight ocean, and make its short journey over the heavens. As far north as Saint Petersburg, Florida, Beta, Gamma, and Delta Crucis are visible for a very short time, but Alpha remains, tantalizingly, just below the horizon. At Long Key, on the 11th of June, at the beach known as "Passe a Grille," I watched the head of the Cross rise out of the water and describe its narrow arc and disappear. Being at the time of the rainy season, low clouds obscured Beta and Delta, but the orange light of Gamma was clearly visible.

CENTAURUS.

"For the sun had now to Taurus the meridian circle left,
And to the Scorpion left the night." DANTE.

Before Scorpio lifts his magnificent curves high above the horizon, one feels a sort of mystery in the south, and this feeling of expectancy is heightened as, star by star, one traces the splendid outlines of the torso and spear of the Centaur. One is almost breathless when, above the dusk of the horizon, a blazing, red star and blue-hued companion float into view, adding a striking figure to the heavens, and completing the heroic constellation of Centaurus. The general impression given by Centaurus is of a collection of many bright stars scattered in pleasing relationships, with a focus of interest for the eye at the distinguished first magnitude stars, Alpha and Beta. The delight, to the modern eye at least, is in a sort of geometrical harmony, for the stars are distributed over too much space to give to the fancy the sense of form and movement that is manifest, for instance, in the illusion of rampant Sagittarius.

This remarkable constellation is situated between Scorpio and Argo and covers about 60 degrees in length. According to most astronomers it contains about three hundred eighty-nine stars visible to the naked eye, among them being two of the first magnitude, two of the second magnitude, and seven of the third magnitude. It is an ancient constellation, having been mentioned by Aratos near 270 B. C. and many authorities agree that there is sufficient evidence to place its name, configuration, and significance thousands of years previous to this.

In Centaurus was located the famous temporary star which the Chinese astronomers saw and recorded 173 A.D. The faithfulness of the Chinese in recording all phenomena of the heavens, and a certain systematic method of handling their data has been of great benefit to astronomers. But the poetic and impressionistic way in which they dealt with details of description may be seen from the following account of this temporary star in Centaurus: "On December 10 a star appeared between Alpha and Beta Centauri and remained visible for seven or eight months. It was like a large bamboo mat and displayed five different colors." Whether this object was a temporary star, or a variable, or a comet, or some other manifestation, is not known, but the same phenomenon appears to have been observed and recorded by Greek astronomers.

Centaurus also contains a globular star cluster which is one of the curiosities of the sky. This is found about 36 degrees south of Spica, and appears to the naked eye like a nebulous fourth magnitude star. With a good field glass the composite nature of the cluster may be seen. and the imagination is held captive by its illusive beauty and apparent variable brightness, and by the occult qualities of its origin and probable history. It is of special interest and beauty when it comes to the meridian about the first of June. At this time the size, brightness, and color appear to change, this aspect being due, doubtless, to the atmospheric conditions that prevail at the rainy season. At times it seems to float like an airy, nebulous ball, as if between the observer and the farther background of the sky, when, at the intervention of some thin, vapory cloud, it disappears altogether.

Through the telescope it is a dense, globular mass of five thousand stars covering a space about 20 minutes in diameter. It has been described as presenting great variations in brightness because of the little knots or groups into which the stars are collected; and by all observers it has been classed as one of the most beautiful of stellar aggregations. This cluster, Omega Centauri, Halley recorded in his catalogue in 1677 as a nebula, and it was Sir John Herschel who, by the aid of his better telescope, resolved it into the globular cluster which he termed "beyond all comparison the richest and largest in the heavens."

The two brightest stars of the constellation are Alpha and Beta, situated near the ankles of the Centaur, about 30 degrees from the South Pole, and 80 degrees south of Arcturus. They are brilliant first magnitude stars almost as close together as Castor and Pollux, and are of contrasting hues, Alpha being red and Beta blue-white, which, of course, adds much to their conspicuous beauty. The difference of opinion in regard to star colors has long been a matter of comment, and while the color of Beta is often given as white, to me it is distinctly blue and sapphire-like.

Among the twenty brightest stars, Alpha Centauri ranks third and Beta tenth; and when on the meridian, they are seen in company with Arcturus, Regulus, Spica, Antares, and Alpha Crucis, all first magnitude stars. Alpha is a double star, and its components are each brighter than our sun, while the combined light is nearly four times as much as that of the sun. Alpha, also, has the distinction of being the star of all the universe nearest to us so far as can now be determined, a fact of great interest and moment to astronomers. The fact that this nearest star is four light-years away, or twenty-five billion miles away, is another overwhelming revelation of stellar distances. It is doubtless true that Alpha Centauri was worshipped on the Nile, and Lockyer goes so far as to say that over a dozen Egyptian temples were built with reference to its heliacal rising at the autumnal equinox. Alpha and Beta, with the Southern Cross, have served as compass for mariner and landsman, being used in the southern hemisphere as a means of fixing the directions as the "Big Dipper" and the North Star are used in the northern hemisphere. Neither of these stars is visible north of the 29th parallel.

The lantern-like delusion of some of the stars is persistent, and especially marked is it to me in the aspects of Achernar and Alpha Centauri. On a dusky horizon, among the lights and masts of the motley array of boats assembled about Port Tampa, I have seen Alpha Centauri float into view, red and misty, like the menacing headlight of the terrible Khaireddin Pacha or the lantern of some phantom ship. And to me, Alpha and Beta Centauri are always associated with the cool, moist evenings at the beginning of the Florida rainy season, when one sees the unusual combination of a brilliant sunset and dark storm clouds. One June evening is recalled distinctly when I rode for several miles with an orange and grapefruit grove on my left, and Alpha Centauri's red light bounding along just above the dark foliage line of the horizon, while Beta was quite obscured by low-hanging clouds. It was on this same evening, by the side of a much frequented road, that I discovered an alligator between six and seven feet long half hidden in a moist growth of penny-wort!

These two stars bring to mind the full June blossoming of the antigonon, the heavy clusters of the great blue thunbergia, and the late flowers of orange and grapefruit trees. They mark the beginning of the exuberant tropical summer with its days of fierce heat and passionate showers, and its velvety, fragrant nights with "stars to all eternity!"

ERIDANUS.

"For now
The Pisces play with undulating glance,
Along the horizon, and the Wain lies all
O'er the north-west."

DANTE

South of Taurus and near the bright Rigel, the pale stars of Eridanus begin to flicker and to lead the eye from one point of light to another, while the fancy slips along as if carried by the slow current of the river. Among all the southern constellations none has a more mysterious influence upon the imagination than Eridanus as it meanders lazily with its limpid stars, in and out among other star-ways, and, at last, empties its light into the lantern of Achernar. The name itself is mythical and poetic, and the constellation, wherever traced by loving watchers of the night, seems to have been identified with some mighty river. The names of the Po, the Rhone, the Rhine, the Volga, the Euphrates, and the Nile have all been associated with this stream of stars, and its power over the imagination has been enriched by legend and story. There was a fabled stream of northern Europe flowing into a vast ocean, a stream told of in folk song and story. It has been called the "nowhere-existing" river, and one meets it often in Russian folk lore, and here and there in Turkish, Persian, Greek and Sanskrit. It is not difficult to trace the identification of this fabled river with the vague and wandering stars of Eridanus. Aratos speaks of it as a "stream of tears," and Homer, Hesiod, Plautus, and others, have allusions that are supposed to refer to the River of the Sky. Eridanus contains about sixty stars visible to the naked eye, none being brighter than the third magnitude with the exception of Achernar. The part of the heavens traversed by the River is strangely dark and lonely. Between Rigel and Fomalhaut there are no bright stars, the Milky Way does not cross that region, and there are no conspicuous groups like Orion, Scorpio, or Crux. The sky is a dark unfathomable verge rendered still more mysterious by the uncertain tracery of faint stars and the solitary brilliancy of Fomalhaut and Achernar.

In northern latitudes Eridanus is not a noticeable constellation, for but a part of it can be seen, and this section contains no bright stars. Its entire length, covering about fifty degrees from north to south, must be viewed, and its culmination in the beautiful Achernar, in order to understand why it so captivated the imagination. Beta Eridani is a yellow third magnitude star a little north and west of Rigel, and is the most conspicuous star of the constellation, seen from the latitude of New York City. Theta Eridani is a double star, pale yellow in color, which marks about the southern limit of the constellation as seen from 40 degrees north latitude. On winter evenings in December and January this star may be seen low in the south on the meridian; it is a third magnitude star, but from records which have come down to us, it is probable that its brilliancy has diminished and that at one time it was of the first magnitude. The great star of the constellation, of course, is Achernar, marking the end of the River. It is almost directly south

of the star in Cetus known as Baten Kaitos, and is 32 degrees from the South Pole. It ranks 9th among the twenty brightest stars, coming just after Procyon and before Beta Centauri, and is the only bright one in that part of the heavens. Achernar does not appear to have been a temple star, and special mention of it occurs less often than one would expect from its brightness and beauty. In very remote times, the Precession of the Equinoxes must have brought it into view as far north as the 40th parallel, but in Ptolemy's time it was not visible north of Alexandria. Although often spoken of as a white star, to me Achernar is always tinged with gold. When seen rising in the early evening it has a strong glow of gold, sometimes almost turning to ruddy, with less color as it mounts higher in the heavens; but it always shows in its light a touch of yellow.

One of the chief charms of the stars to those who study them at all times of the night and in all seasons of the year, is the apparent difference in aspect, color, and character which comes from atmospheric conditions. Whatever of fact may be revealed by the telescope, the photometer, the camera, or the spectroscope, certain conditions will always produce effects of beauty and wonder for the eye, that must make an appeal to the aesthetic sense and stimulate the fancy. All stars present a different phase to the imagination when viewed between midnight and dawn, from that which greets us as they rise in the early evening. And so we find Achernar, floating now with a lantern-like aspect, and again glittering with the intensity of a jewel. During most of August and part of September it comes to the meridian in the early morning between three o'clock and dawn, when of all hours, the heavens seem most mysterious and beautiful. Then it shines with a clear, pale light, warm, palpitating, and still. It is the perfect star of the morning, and brings visions of the first faint hint of dawn, the purple-streaked water of the Gulf of Mexico, and the drowsy dripping of the dew from long, drooping banana leaves. Whether seen low and enveloped with the warm breath from the sea, or seen on the meridian surrounded by the peculiar deep immensity that marks the end of the River, Achernar always shines like some great beacon hung out in space, forever luring the imagination.

(*To be continued.*)

REPORT ON MARS, No. 9.

WILLIAM H. PICKERING.

This Report will be devoted, not like its predecessors, to a description of observations and changes noted upon the planet, but instead to suggestions to amateur and professional observers, with regard to the coming opposition. The best scale for the drawings of Mars is three millimetres (⅛ of an inch) to the second of arc. This will be found more convenient than to make them all on the same scale. The drawings are, for ready comparison, all placed on the right hand page of the record book, and below each should be entered the times, magnification, and quality of the seeing. Beneath is left a space for the insertion of the computed angular diameter, central meridian, latitude of the center, and martian date. Three or more circles of the proper size are prepared beforehand by means of the *American Ephemeris* or *Nautical Almanac*, the polar and phase axes inserted, and the phase arc drawn. This latter can be done with sufficient accuracy with dividers, using a larger radius than for the circumference of the disc when the phase is large, and finishing by hand.

It is the writer's custom to orient his drawings either by means of the north polar cap, or, when that is not available, by a spider-line set at the proper computed angle in the eye-piece. The north polar cap is first drawn, care being taken to get it of just the right size. Next we put in any conspicuous detail that may happen to be near the center of the disk, and then whatever is on the limb and nearly opposite to the polar cap. The limb is next spaced off by the eye, and other limb detail drawn. After this whatever is left can be inserted without large error. After the main features are completed, the outlines of the minuter details are drawn, beginning on the preceding side of the disk, so as to lose as little detail as possible by the rotation of the planet. The drawing of the outlines usually requires from ten to twenty minutes. The mean of the times of beginning and end gives the longitude of the central meridian.

The shading is next done, which occupies about ten minutes, and then a careful comparison of the drawing is made with the planet, and any defects that are detected are remedied. We next insert a low power eye-piece (0.6 in. focus), giving a magnification of 330, and

search for any faint contrasts, particularly in the more uniformly illuminated regions both bright and dark. We then record the colors visible with this eye-piece, and often the brightness of the different areas, making if necessary a supplementary drawing copied hastily from the first one. Finally we again insert the higher power and confirm these colors, again recording the time. The low power seldom shows any detail that has not been detected by the higher one, but if the contrast is slight, it shows it to better advantage. It also brings out the colors in the larger surfaces more clearly, because of the increased light. It is in this study of color, as we shall presently see, that we most feel the need of a large aperture, that is we need more light. As far as definition is concerned most of the detail that we have seen at this past opposition would have been visible had the aperture been reduced to 5 inches, and several of the canals notably Nilosyrtis, Thoth, Eunostos, Lethes, and Cerberus were recorded as clearly visible in our 3-inch finder, when using a magnification of 180.

For comparison of the quality of the seeing at different stations, or on different nights at the same station, the so-called Standard Scale is recommended. Indeed it is the only method by which these comparisons can be made with any certainty, and is of universal application. This description of it is copied with one or two slight modifications from the *Harvard Annals* **61**, 29. The objective must be a good one. and in perfect adjustment, that is the diffraction rings must be complete circles, not mere arcs. A bright star, preferably of the first or second magnitude should be examined, using a ¼-inch eye-piece. This gives a magnification of about 60 to the inch of aperture.

As adapted to a 5-inch telescope the scale is as follows:—

1. Image about twice the usual size. That is twice the diameter of the third diffraction ring.
2. Image occasionally twice the usual size.
3. Image of about the usual size, and brighter at the center.
4. Disk often visible, short arcs occasionally seen.
5. Disk always visible, short arcs seen about half the time.
6. Disk always visible, short arcs constantly seen.
7. Disk sometimes sharply defined.
8. Disk always sharply defined. Rings all in motion.
9. Rings. Inner one stationary.
10. Rings. All stationary, or in slow motion.

If we double the aperture of the telescope we must add two units to the scale. For a 7-inch telescope perfect seeing would be 11, for a 10-inch it is 12, for a 14-inch 13, etc.

It is of little use to observe Mars when the seeing is below 6, or when its altitude is below 30°. When the seeing is really good on Mars,

the last three units of the scale, the amount of fine detail visible remains just about the same. The chief difference that we have noticed is that with good seeing one can draw faster, as one does not have to wait for clearer glimpses, between intervals when all is blurred. On account of the rapid rotation of the planet, greater accuracy is secured by rapid drawing. Also, with good seeing, the observer has more time to carefully compare and criticize his work.

By a comparison with the spider line in the eye-piece, it was found at this last opposition, that the breadth of an average canal was about the same as that of Cassini's division at the ansae in Saturn's ring, the canal was however very much fainter. Encke's division cannot be distinguished when the seeing is below 7. It is much narrower than most of the canals.

The writer does not consider that in the case of an astronomical drawing any attempt should be made to shade the object exactly as it appears to the eye, but only to produce an approximation to the truth. We can never obtain on paper the extreme range of illumination usually visible in the telescope. It is therefore impossible to represent objects as they really appear. Hence contrasts which are of no consequence should be reduced, in order that contrasts more important for our purposes may be increased. If drawn exactly as it appears to the eye, the surface of Mars would be represented much darker than the polar caps, and the more faintly marked contrasts of the surface would not be visible at all, or at least seen only by means of special diagrams. Therefore small contrasts are always exaggerated. The power to do this constitutes one of the chief advantages of a drawing over a photograph, where such selective exaggeration is impossible, and in consequence much is lost. This difficulty may be partially overcome by printing in colors, but the added expense of the process is at present prohibitive for most purposes.

The breadth of the canals and diameters of the lakes may be measured, and their densities determined, by a scale of canals or lakes attached to the outside of the tube of the telescope, near the objective, as described in Report No. 7. The brightness of the surface features can be recorded on a scale of 10, similar to that employed by selenographers for the moon, as described in Report No. 4. On this scale the polar snows are marked 10, the polar clouds generally 8, the deserts 6 to 7, most of the *maria* 3, and the blackest lakes 1.

The colors of the surface are most important, but some persons find difficulty in properly describing them, perhaps because their eyes are not suited for this kind of work. The *maria* are sometimes green and sometimes grey. The clouds are sometimes yellow and sometimes white. Occasionally an intense vivid green, which seems to be subject-

ive, appears on the limb, or in the polar areas. The marshes are sometimes a deep intense blue but when near the limb the blues are usually very light. This leads us to believe that the atmosphere of Mars is sufficiently dense to reflect a considerable amount of sunlight. The deserts vary from yellow to orange red, the latter color in the case of observations made by daylight.

Before attempting to represent the colors seen through the telescope there are a few points which we must consider, and which should be kept clearly in mind. The first of these is that *the source of light illuminating the paper should be, if possible, of the same color as the sun, as seen from the distant body.* But a few years ago there were only two practicable methods of illuminating the paper in our studies of color at the telescope, the oil lamp and daylight. Latterly we have had the carbon filament, the color of which however is but little whiter than that of the oil lamp. At the last opposition we were successful in having some tungsten lamps of only 2 and 5 c. p. made to order for us. These threw much light on the color phenomena of the planet, and it is expected that at the coming opposition by transmitting their light through pale blue glass, we shall be able to render the illumination of our paper of very nearly the same color as the illumination of the surface of Mars by the sun. Sunlight, while much bluer than the unprotected tungsten filament, is at the same time decidedly more yellow than the ordinary daylight illumination of our sky.

The color of the illumination if it is white enough to show the blues at all, affects our studies of them, and of the greens far less than it does that of the reds and yellows. By the yellow light of the carbon filament the tendency is to paint the greens and blues rather too intense, but we paint the reds and yellows much too pale. Indeed, plain white paper sometimes appears redder than the planet itself. This is doubtless due to martian cloud or haze, and was recorded three times during the past opposition. By the light of an oil lamp it is difficult to distinguish crimson lake from golden yellow, and either will at times match the planet. By the unprotected tungsten light the center of the disk can usually be matched by yellow ochre. By the magnesium light, which is our bluest source of illumination next to sunlight and the vacuum tube, the color of the disk has been matched with dragon's blood. This is pretty near its true color.

A difficulty that arises in making daylight studies of the planet, which would otherwise be very satisfactory, is that the illumination of our own atmosphere mixes a certain amount of color with that due to the planet itself. This is well illustrated by viewing a distant landscape through a telescope and attempting to paint it. A bright red brick

building seen from a distance of two or three miles is best matched not by red, but by chrome orange, while as we all know the grass on a distant mountain appears light blue instead of green, and darker colored foliage dark blue or grey. Thus it is impossible to represent the true colors by this method. The best we can do is to obtain results from which we may conclude what the true colors really are. If on the other hand this distant foliage is illuminated at night by an arc light, and we view it through the telescope, the grey or blue is replaced by a bright green, which we at once recognize as the true color that we should find if we visited the tree by daylight. From this we conclude that all studies of color should be made at night, and that to get the best results our paper must be illuminated by a light of as nearly the color of direct sunlight as possible.

The simplest method of determining what shade of blue glass we should employ in front of our tungsten light is to reflect sunlight through a very small aperture into a darkened room. We may then compare it directly with the tungsten light by means of a shadow photometer. As high a voltage as practicable should be used, when this can be varied. A method that may sometimes be more convenient is to reflect the sunlight from an adjustable mirror onto four successive plane sheets of glass, arranged so as to throw the light back and forth nearly perpendicular to their surfaces. This may be done out of doors. This will reduce the intensity of the light about ten thousand times, so that we may look directly at the image and compare its color with that of the tungsten filament, whose intensity will also be reduced by looking at it through half a dozen sheets of very pale blue glass. A point of great importance is that the brightness of our paper should equal as nearly as may be the brightness of the planet as seen through the telescope. The blue glass greatly reduces the brightness of the tungsten light, so that even if a high candle power lamp is employed the illumination will be rather faint. In Report No. 7 we found that a sheet of white paper illuminated by a 5 c.p. tungsten light at a distance of 6.5 inches was as bright intrinsically as Mars viewed with the 11-inch aperture and a magnification of 430. With blue glass of such density as to give the color of sunlight, when placed in front of a tungsten lamp, the brightness is reduced to 4.5 per cent. We shall obtain the proper illumination of the paper therefore with blue glass if we use a 10 c. p. light at a distance of 3 inches, and use a magnification of 660 in the telescope. A 25 or 50 c. p. light, possibly with a reflector attached, at a somewhat greater distance would be more convenient in practice. Indeed when the paper is painted red or orange a lamp of this brightness will certainly be necessary. The spectrum of the tungsten light through

blue glass gives plenty of red, yellow, and violet rays, and shows no absorption bands. In general effect it is very like the solar spectrum.

We should determine once for all the distance that the lamp should be held from the paper, for each different eyepiece that we employ. A high power always makes the planet appear redder than a low one. This is simply because the illumination is less. But besides this the objective and eye-pieces themselves absorb a perceptible amount of the blue and green rays, so that if we point the telescope by daylight on some distant trees, or on the sky, and look with one eye through the telescope, and the other directly at the object, we shall find that to get the same color effect we should place a piece of light blue glass in front of the eyepiece.

Under faint illumination all colors tend to appear grey, but this is particularly so of blues and greens. If in order to avoid this we diminish the magnification, thus making the planet brighter, the smaller areas may become so small that they fail to show any color at all. We must therefore select our magnification with regard to the size of the object in view. A large aperture is for this reason of the greatest advantage for color studies, and little can be done with very small apertures. It is a good plan to cut a round hole of the proposed size of our drawing of Mars, in a piece of black paper. This we can occasionally lay over the drawing, thereby imitating the effect of contrast with the dark sky.

The blues and greens are seen to best advantage in the night time, but if our own atmosphere is very clear, especially in the early morning, the blues may be seen till near sunrise, and the greens somewhat later. The blues can be detected after the planet is invisible to the naked eye. In March and April 1892 paintings were made by daylight in which the green, yellow, and orange exactly match these colors as applied at night by the carbon filament in December 1914. This would imply a distinct change in the real color of the desert regions of the planet at different seasons.

During his earlier work in past years the writer employed water colors exclusively to record the colors observed. This still seems to be the best plan for the ground work of the disk, the yellow ochre, orange, and reds, but for the greens, blues, and browns he has latterly used colored pencils, and finds the manipulation much quicker, and more adaptable in connection with lead pencils of varying degrees of hardness.

In Report No. 8 are given four plates showing Mars in six different positions, as seen by five different observers. These six positions indicated as A, B, C, D, etc., are drawn with martian longitudes 0°, 60°, 120°, 180°, 240°, and 300° central, and give therefore a complete representation of the appearance of the planet at this last opposition. It is hoped to continue this publication next year. In order that drawings

by different observers, executed at different times, may be fully comparable, it is very desirable that the planet should be as nearly as possible in the same position. It is therefore recommended to other observers that they should adopt these same positions as far as practicable for making their drawings, and should therefore compute beforehand the hours at which their observations should be made. It is not by any means intended to discourage drawings made at other times, as for instance might be necessary between passing clouds, but merely to suggest that drawings should be made by all observers, when equally convenient to do so, in these six positions.

To find the hour on a given date when the particular martian longitude is central at any place upon the earth's surface, let l equal the martian longitude selected, m the martian Central Meridian given in the Ephemeris for the date in question, and r the number of degrees rotated by Mars in one hour, as seen from the earth. For ordinary purposes this last may be taken as $14^\circ.62$.

Let T equal the difference in the time used by the observer and at Greenwich. Then t will equal the required number of hours to be added to Greenwich Mean Noon or Midnight.

For west longitude we have $t = \frac{l - m}{14.62} - T$, and for east longitude $t = \frac{l - m}{14.62} + T$. When necessary add 360° to l, and 24^h to $\frac{l - m}{14.62}$. The same meridian is central about 37^m later on successive nights. To find on what night at any given hour a selected longitude will be central on Mars, solve with regard to m and look up the date in the *Ephemeris*. To find what meridian is central on any given drawing solve with regard to l.

For 1915 the *American Ephemeris* uses Washington Mean Noon. To correct to Greenwich Midnight add $100^\circ.3$ to m. For 1916 it uses Greenwich Mean Noon. It is to be hoped that later it will finally adopt Greenwich Midnight, as it has done in the case of the Moon, and as is now in use by the *British Nautical Almanac* for both of these quantities. This plan would render interpolation more accurate, and would show at a glance what is visible here in the early evening.

In the question of identification of the lakes and canals, on martian drawings there is always liable to be an element of uncertainty, particularly if they are far removed from the assured detail. This is due in part to errors of drawing, and in part to the shifting of the canals themselves over the surface, both laterally and in position angle. Thus Tartarus may change to Trais (Lowell), and Pactolus to Hephaestus.

There are two independent methods of identification when in doubt, one by the configuration of the surrounding surface, and the other by the latitude and longitude. When they differ the observer must use his judgment which to employ. The former is in most cases the better but if the marking is far from any certainly known feature, and is near the center of the disk, the latter is sometimes to be preferred. This is particularly true of a lake. When a very faint canal is seen one night standing out by itself, and a few nights later another very faint canal in nearly the same place, also standing by itself, the question at once arises are they really two different canals, or is it a case of an error in drawing? Since very faint canals are so easily concealed by martian clouds, the writer prefers in most cases not to go back of the observations, but to identify them as two distinct canals. If, however, one of them has never been observed before, he would usually consider that an error had been made in the drawing.

Again a canal may be so broad as to cover two parallel canals, or may lie just between them. This was the case early in 1914 with the canals Galaxias of Schiaparelli, and Achelaus of Lowell, between Elysium and the southern *maria*. It does not seem desirable under these circumstances to give the canal another name, and usually the earlier name is preferred. In that particular instance however the configuration agreed better with Achelaus, so that that name was adopted.

Another difficulty is to decide when a marking may properly be called a canal. Thus Cerberus on November 17 was 310 miles in width by 800 miles in length. The question might properly be raised could such a marking be designated as a canal? Yet in January and February it had narrowed to but half its former breadth. Nilosyrtis November 7 was 330 miles in breadth and 1500 miles in length. By February 24 it had narrowed to 50 miles. It was then certainly a canal. A more puzzling case was that where the whole triangular area bounded by Jamuna, Ganges, and Nilokeras on January 5 was darkened, uniform and sharply defined. Could it properly be said that these three canals were visible, or should we wait until a lighter spot appeared within the dark region? If we are discussing vegetation, they certainly had appeared, if we are discussing topography, perhaps not. Again should we say that Hydraotes which crosses the center of this region and extends beyond it, had also appeared? Since it is certain that for much of the time many of the canals are broad markings, the writer has decided to record a canal as having appeared, regardless of its shape, when its position is correctly indicated, and the region it crosses is dark. If only one side is visible it might be indicated thus:—Ganges /2, but if neither side were visible it would not be recorded at all. Therefore on January 5 we should record as visible Jamuna /2, Ganges /2, and Nilokeras /2, but not Hydraotes.

In considering what we should look for this year it would be of particular interest to confirm those changes that were seen at the last opposition. It it not expected that they will necessarily occur however, and certainly not upon the same martian dates. At each opposition the martian date, see Report No. 2 where it is referred to as the Equivalent Terrestrial date, falls 42 to 44 days earlier in our calendar year than at the last. That is, their seasons will arrive 44 of our days earlier this year than they did two years ago. At the same time owing to the greater speed of our planet, we shall gradually pass them, so that while in those observations made previous to the martian date of April 24, we shall see Mars less well than formerly, after that martian date which occurs January 2, 1916 of our calendar, we shall see it better. This is illustrated in Figure 1, where the positions that the two planets occupy

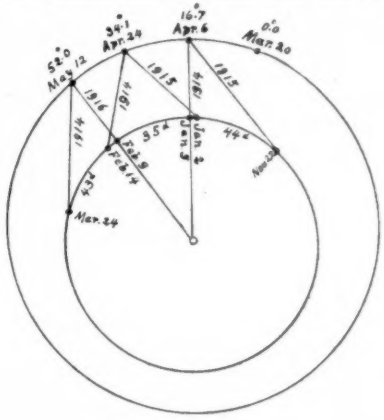


FIGURE 1.

on the same martian date in two different years are joined by lines, the martian and terrestrial dates being given in each case, also the solar longitude ☉. The two oppositions here considered fall on January 5, 1914, and February 9, 1916. It is hardly worth while to observe the planet before its diameter reaches 6″, which will be seen on September 11. It will then be seen to best advantage just before sunrise, as it transits our meridian at $19^h\ 45^m$.

At this time we shall expect to see the northern polar cap at about its maximum size, and surrounded by a broad grey band, darker in spots. The southern *maria* should also be grey, not turning green until early in October. About the same time Sabaeus and Margaritifer will develop, and begin to assume their characteristic forms, and a few of the canals connecting the snow cap with the *maria* should become visible as broad bands. By the middle of October some of the great marshes bounding the northern polar cap should have begun to form

and should exhibit noticeable changes from night to night, if the planet is well seen, together with a slow but distinct shifting towards the geographical west, i.e. following direction, (Report No. 4.) It will be interesting to note if the twin triangular bays near Propontis, so characteristic of the last opposition again appear. The martian vernal equinox falls on October 19 of our calendar year in 1915. Changes in the Protei Regio may occur about the middle of November, together with the first appearance of Solis Lacus, but they will both be pretty near the limb owing to the high northern latitude of the center of the disk, rendering the southern hemisphere badly seen at this opposition.

The flooding of the Syrtis marsh, described in Report No. 4, occurred last year on January 17. The planet would occupy the same position in its orbit this year December 4, but it is thought that several floods may occur, some perhaps earlier and some later than this, so that we may set this date merely as about the time to look for them. The changes in color and distinctness, as well as in shape and size, of the dark area at the extreme northern end of the Syrtis should be carefully noted each night. Sabaeus should also be watched for a possible blue coloration in February and March. See Report Brit. Astron. Assoc. for 1901. Mem. **11**, 95.

A gradual change in color of the so-called desert regions would be most suggestive if confirmed, and could best be detected by comparison with a sheet of white or lightly tinted paper. On this should be laid a piece of black paper in which was cut a circular hole of about the same apparent size, when held at a convenient distance, as the planet. With a uniform source of light placed at the proper distance from it, comparisons made throughout the opposition might yield interesting results even in a poor climate.

According to Major Molesworth the surface on one side of a faint canal is often slightly darker than on the other. This statement is made not as an explanation of the canals, as proposed many years ago by Green, but as an interesting phenomenon supposed to be associated with them. Molesworth observed in an excellent climate, and his statements deserve high credence. Favorably situated observers should look with care for this appearance at the coming opposition. It is undoubtedly true in some cases, as for instance Triton this past year.

According to the experience of Schiaparelli in 1882 this opposition should be a favorable one for detecting the duplication of the canals. The appearance, if dependent on the martian seasons, should be visible throughout December, and should probably be looked for also in January. According to his earlier statements and maps the separation lies between 0″.7 and 1″.5 but he later reduced his figures one half when he obtained his larger telescope. The duplication should hardly be visible therefore

to anyone unable to detect the duplication of the lunar canal in the interior of Aristillus. This is a divergent double, the separation at the rim being 0″.7. Observers wishing to know if their outfit is adapted to seeing the martian doubles, can readily test it at the proper colongitude upon this lunar canal (POPULAR ASTRONOMY, November 1914.)

Micrometric measurements of clearly defined points on the surface, throughout the opposition, and particularly of the following sides of the northern polar marshes, to show the probable shift of these features are very desirable (Reports Nos. 4 and 5). Determinations of the longitude of Juventae Fons, by transit across the central meridian, should be made when possible.

Especial attention should be made in the case of drawings to the regions of Solis Lacus and Syrtis Major, during the months of October, November, December, and January. In order to facilitate the study of the latter object Table I has been prepared, where the first column gives the terrestrial longitude of the observer, and the second the approximate date at which the Syrtis region, martian longitude 300°, can be favorably observed at the hour indicated at the head of the

TABLE I.

DATES WHEN THE SYRTIS MAJOR MAY BE OBSERVED.

Longitude	17h	Begin	17h	Begin	17h	Begin
°		h		h		h
0	Oct. 10	16.0	Nov. 15	14.9	Dec. 23	13.1
30 W	" 12	16.0	" 18	14.8	" 26	12.9
60 "	" 15	15.9	" 21	14.6	" 29	12.7
90 "	" 18	15.8	" 24	14.5	Jan. 2	12.4
120 "	" 21	15.7	" 27	14.4	" 6	12.2
150 "	" 24	15.6	" 30	14.2	" 9	12.0
180	" 27	15.5	Dec. 4	14.1	" 13	11.7
150 E	" 30	15.4	" 7	13.9	" 16	11.4
120 "	Nov. 3	15.3	" 10	13.8	" 19	11.2
90 "	" 6	15.2	" 13	13.6	" 23	10.9
60 "	" 9	15.1	" 16	13.5	" 26	10.6
30 "	" 12	15.0	" 19	13.3	" 29	10.3
0	" 15	14.9	" 23	13.1	Feb. 2	10.0

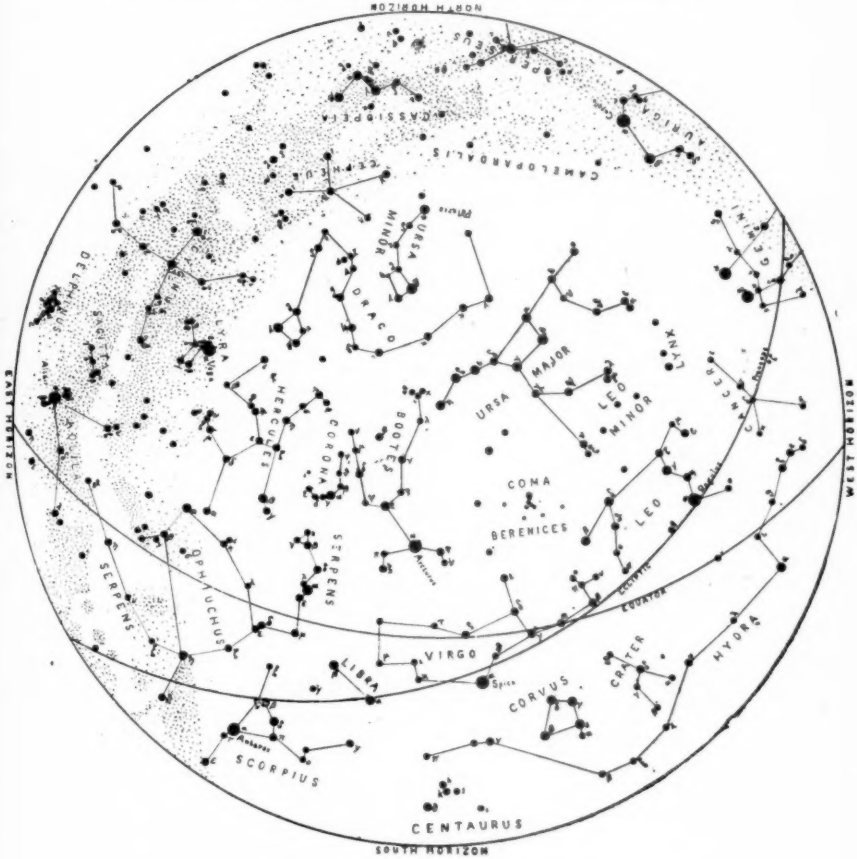
column. The third column gives the hour at which observations may profitably be begun, which is assumed to be three hours before the planet transits the meridian. On favorable nights observations may occasionally be begun an hour earlier. The remaining four columns are arranged like the second and third. If the dates indicated are cloudy, observations made a day or two later will serve nearly as well. *Observations on as many successive dates as possible should be secured by each observer, should there be any evidence of local*

darkening in the Syrtis (Report No. 4.) In January the planet is visible for a considerable portion of each night, so that the range of favorable dates is materially extended, and we may observe much earlier in the night if more convenient. If we remember that the same meridian is central about 37 minutes later on successive nights, it will be easy to compute the proper hour for observation upon any other date. The writer will be glad to receive any drawings or observations made of the Syrtis region during these four months, and will return them at the end of that time if requested to do so. On account of the inconvenient hours, it is not expected that many observations will be secured, and those received will therefore be of greatly enhanced value.

The table has other uses besides that above specified however. By it we may tell approximately what region of the planet will be visible in any terrestrial longitude, at any date and hour during the period above specified. This is done by interpolating along the horizontal lines. Thus for any station using Central Time, we look along the fourth row, and find that martian longitude 300° was central at 17^h (5 a. m.) on October 18, and again 37 days later November 24. The planet therefore changes by 360° in 37 days. Longitude 280° for instance will therefore be central at the same hour two days later, October 20, and longitude 240° October 24. Since the planet rotates 14°.6 an hour, we may readily compute the longitude that will be central for different hours than that given. The table will therefore serve as a crude substitute for the Nautical Almanac to those amateurs not provided with that useful volume.

PLANET NOTES FOR JUNE, 1915.

The sun will move eastward, passing from the constellation Taurus into Gemini during the month. At the end of the month it will be a few degrees south of and about an hour preceding Pollux. The Sun will be at its greatest northern declination on Tuesday June 22. This is the time of the summer solstice, and the time when the sun is said to enter the sign of the zodiac Cancer. The sun however will not enter the constellation Cancer until about the middle of July.



THE CONSTELLATIONS AT 9:00 P. M. JUNE 1.

The phases of the moon for this month are as follows:

Last Quarter	June 4	at 11 A.M.	C.S.T.
New Moon	12	" 1 P.M.	"
First Quarter	20	" 8 A.M.	"
Full Moon	26	" 10 P.M.	"

Mercury will be visible in the west at the beginning of the month at sunset and will set about an hour and a half after the sun. It will move eastward until about the middle of the month when it will move toward the sun, and on June 26 it will pass between the earth and the sun.

Venus will be moving north and east at nearly the same rate as the sun. It will pass through Taurus, not very far from the Pleiades. It will remain visible in the morning sky throughout the month. At the close it will rise about an hour and a half before the sun and will be a short distance east of Aldebaran.

Mars will rise a little earlier each morning. Even at the close of the month it will not rise before the early morning and will still be very far away. It will be coming into better position and also be getting closer to the earth.

Jupiter will be moving eastward slowly. On June 18 it will be in quadrature with the sun, 90 degrees west. It will still be south of the equator and moving northward slowly.

Saturn will be too near the sun to be observed during this month. On June 28 it will be in conjunction with the sun.

Uranus will rise before midnight during this month. It will be in the neighborhood of the boundary between Aquarius and Capricornus.

Neptune will be in the western sky at sunset during this month. It may however be easily observed throughout the month. It will be found in the western part of the constellation Cancer.

Occultations Visible at Washington.

Date 1915	Star's Name	Magnitude	IMMERSION. Washington M.T.	Angle from N.	EMERSION. Washington M.T.	Angle from N.	Duration
			h m	°	h m	°	h m
June 1	20 Capricorni	6.2	11 49	112	12 42	210	0 53
2	μ Capricorni	5.2	12 36	120	13 16	190	0 40
4	13 Piscium	6.4	15 32	94	16 30	189	0 58
19	359 B Leonis	6.3	6 55	153	8 6	285	1 10
25	43 Ophiuchi	5.4	14 3	38	14 50	308	0 47
27	51 Sagittarii	5.8	13 13	32	14 15	286	1 2
27	*h* Sagittarii	4.7	13 17	77	14 33	238	1 16

Phenomena of Jupiter's Satellites.

[Visible at Washington.]

CENTRAL STANDARD TIME.

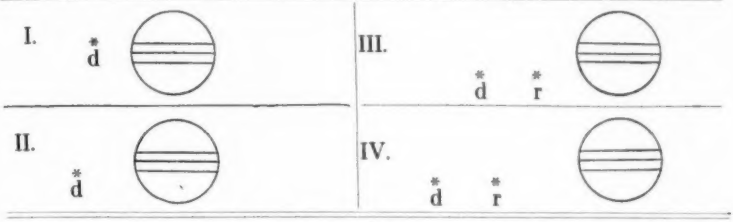
	h m				h m			
June 1	14 43	III	Tr.	Eg.	June 21	12 38	II	Tr. Eg.
3	15 10	II	Tr.	In.	21	12 38	I	Tr. In.
5	12 58	I	Sh.	In.	21	13 33	I	Sh. Eg.
5	12 59	II	Oc.	Re.	21	14 55	I	Tr. Eg.
5	14 21	I	Tr.	In.	22	12 6	I	Oc. Re.
6	13 48	I	Oc.	Re.	26	11 20	III	Ec. Re.
8	12 32	IV	Sh.	Eg.	26	13 53	III	Oc. Dis.
8	13 23	III	Sh.	Eg.	26	15 12	II	Ec. Dis.
10	15 0	II	Sh.	In.	28	12 24	II	Tr. In.
12	14 52	I	Sh.	In.	28	12 27	II	Sh. Eg.
14	13 2	I	Tr.	Eg.	28	13 8	I	Sh. In.
15	14 4	III	Sh.	In.	28	14 31	I	Tr. In.
19	12 37	II	Ec.	Dis.	28	15 14	II	Tr. Eg.
19	12 53	III	Oc.	Re.	29	13 59	I	Oc. Re.
20	13 59	I	Ec.	Dis.	30	11 16	I	Tr. Eg.

Note:—In., denotes ingress; Eg., egress; Dis., disappearance; Re., reappearance, Ec., eclipse; Oc., occultation; Tr., transit of the satellite; Sh., transit of the shadow.

Satellites of Jupiter, June 1915.

WASHINGTON MEAN TIME.

Phases of the Eclipses of the Satellites for an Inverting Telescope.



Configurations at 14h 15m for an Inverting Telescope.

Day	West	East
1	○ 3· ·2	○ ·1 ·4
2	3· ·1	○ ·2 4·
3	·3	○ 2· 1· · 4·
4	2· ·3 ·1	○ ·4
5		○ 1/2 ·3 4·
6		○ 2· ·3 4· ·1●
7	2· 1·	○ 4/3·
8	·2	○ 3· 4· ·1
9	3· 4/1·	○ ·2
10	3/4·	○ 2· 1·
11	4· 2/·3 ·1	○
12	4·	○ 1/·3 ·2●
13	·4	○ 2· ·3 ·1●
14	·4 2· 1·	○ ·3
15	·4 ·2	○ 3/·1
16	3. ·41.	○ ·2
17	3·	○ ·4 1/2·
18	·32· 1·	○ ·4
19		○ ·3 1· 4· ·2●
20	·1	○ ·2 ·3 ·4
21	○ 1· 2·	○ 3· 4·
22	·2	○ ·1 3· 4·
23	3· 1·	○ ·2 4·
24	3·	○ 2/·1 4·
25	·3 2· ·1	○ 4·
26	4· ·2 .3	○ ·1
27	·4 ·1	○ ·2 ·3
28	○ 2· ·4	○ 1· 3·
29	·4 ·2	○ ·3 .1●
30	·4 3·1·	○ ·2

VARIABLE STARS.

Approximate Magnitudes of Variable Stars of Long Period on April 1, 1915.

[Communicated by the Director of Harvard College Observatory, Cambridge, Mass.]

Name.	R. A. 1900. h m	Decl. 1900. ° ′	Magn.	Name.	R.A. 1900 h m	Decl. 1900 ° ′	Magn.
X Androm.	0 10.8	+46 27	10.4	W Cancri	9 4.0	+25 39	13.6
T Cassiop.	17.8	+55 14	8.8	Y Draconis	31.1	+78 18	13.7*d*
R Androm.	18.8	+38 1	8.3 *i*	R Leo. Min.	39.6	+34 58	9.0*d*
U Cassiop.	40.8	+47 43	11.6*d*	R Leonis	42.2	+11 54	8.8*d*
V Androm.	44.6	+35 6	9.4	V Leonis	54.5	+21 44	8.7
W Cassiop.	49.0	+58 1	9.0	R Urs. Maj.	10 37.6	+69 18	8.0*d*
S Cassiop.	1 12.3	+72 5	7.9	SU Virginis	12 0.0	+12 56	10.7*d*
X Cassiop.	49.8	+58 46	9.7*d*	T Virginis	9.5	− 5 29	9.5
U Persei	53.0	+54 20	9.1*d*	R Corvi	14.4	−18 42	10.0 *i*
R Arietis	2 10.4	+24 35	8.4	Y Virginis	28.7	− 3 52	<12.0
o Ceti	14.3	− 3 26	5.2*d*	T Urs. Maj.	31.8	+60 2	11.3*d*
S Persei	15.7	+58 8	9.9 *i*	R Virginis	33.4	+ 7 32	7.2 *i*
R Trianguli	31.0	+33 50	11.0	RS Urs. Maj.	34.4	+59 2	9.0 *i*
W Persei	43.2	+56 34	9.6	S Urs. Maj.	39.6	+61 38	9.7 *i*
Y Persei	3 20.9	+43 50	9.8*d*	U Virginis	46.0	+ 6 6	8.6*d*
R Persei	23.7	+35 20	8.3	R Hydrae	13 24.2	−22 46	5.4 *i*
W Tauri	4 22.2	+15 49	10.4 *i*	S Virginis	27.8	− 6 41	9.4*d*
R Tauri	22.8	+ 9 56	<12.0	R Can. Ven.	44.6	+40 2	7.5
S Tauri	23.7	+ 9 44	<13.0	U Urs. Min.	14 15.1	+67 15	9.0
X Camelop.	32.6	+74 56	11.9*d*	S Bootis	19.5	+54 16	11.8
RX Tauri	32.8	+ 8 9	11.7*d*	R Camelop.	25.1	+84 17	13.2
V Tauri	46.2	+17 22	12.8*d*	V Bootis	25.7	+39 18	8.0
R Orionis	53.6	+ 7 59	9.2	R Bootis	32.8	+27 10	7.2
R Leporis	55.0	−14 57	9.4	S Cor. Bor.	15 17.3	+31 44	6.8
T Leporis	5 0.6	−22 2	11.4	RS Librae	18.5	−22 33	9.0*d*
V Orionis	0.8	+ 3 58	9.6 *i*	S Urs. Min.	33.4	+78 58	9.6 *i*
R Aurigae	9.2	+53 28	9.2	R Serpentis	46.1	+15 26	7.0 *i*
RU Tauri	46.9	+15 57	10.7	U Serpentis	16 2.5	+10 12	<12.0
U Orionis	49.9	+20 10	8.2 *i*	U Herculis	21.4	+19 7	9.0 *i*
Z Aurigae	53.6	+53 18	9.3	W Herculis	31.7	+37 32	12.5
X Aurigae	6 4.4	+50 15	12.2	R Draconis	32.4	+66 58	11.7*d*
V Monoc.	17.7	+ 2 9	8.4	S Herculis	47.4	+15 7	8.4 *i*
S Lyncis	35.9	+58 0	10.0*d*	RV Herculis	56.8	+31 22	14.0
X Gemin.	40.7	+30 23	10.2*d*	T Draconis	17 54.8	+58 14	11.2
Y Monoc.	51.3	+11 22	9.4	T Herculis	18 5.3	+31 0	8.3*d*
X Monoc.	52.4	− 8 56	10.2	W Lyrae	11.5	+36 38	10.9*d*
R Lyncis	53.0	+55 28	7.4	X Ophiuchi	33.6	+ 8 44	8.8
R Gemin.	7 1.3	+22 52	12.4*d*	R Aquilae	19 1.6	+ 8 5	11.2
R Can. Min.	3.2	+10 11	11.0	R Cygni	34.1	+49 58	8.8 *i*
S Can. Min.	27.3	+ 8 32	9.2	RT Cygni	40.8	+48 32	7.3 *i*
T Can. Min.	28.4	+11 58	11.8	TU Cygni	43.3	+48 49	9.4
U Can. Min.	35.9	+ 8 37	11.5*d*	χ Cygni	46.7	+32 40	9.4*d*
S Gemin.	7 37.0	+23 41	13.9	Z Cygni	58.6	+49 46	9.3 *i*
T Gemin.	43.3	+23 59	10.6	U Cygni	20 16.5	+47 35	10.8
R Cancri	8 11.0	+12 2	8.7 *i*	T Cephei	21 8.2	+68 5	9.9*d*
V Cancri	16.0	+17 36	8.5 *i*	S Cephei	36.5	+78 10	11.0*d*
RT Hydrae	24.7	− 5 59	9.0	V Cassiop.	23 7.4	+59 8	7.7
S Hydrae	48.4	+ 3 27	7.8	R Cassiop.	53.3	+50 50	10.4*d*
T Hydrae	50.8	− 8 46	7.8				

The letter *i* denotes that the light is increasing; the letter *d*, that the light is decreasing; the sign $<$, that the variable is fainter than the appended magnitude.

The above magnitudes have been compiled at the Harvard College Observatory from observations made by the following observers:—H. L. Baldwin, H. C. Bancroft, Jr., L. Barbour, T. C. H. Bouton, A. B. Burbeck, H. O. Eaton, G. L. Harrell, F. H. Hay, J. B. Lacchini, C. B. Lindsley, O. Mach, C. Y. McAteer, C. S. Mundt, W. T. Olcott, D. B. Pickering, C. F. Richter, F. H. Spinney, H. M. Swartz, H. W. Vrooman, I. E. Woods, and A. S. Young.

The following stars are being neglected and need to be followed:—

010940	U Andromedae	172809	RU Ophiuchi
011041	UZ Andromedae	175111	RT Ophiuchi
012350	RZ Persei	175519	RY Herculis
013238	RU Andromedae	175654	V Draconis
013338	Y Andromedae	180666	X Draconis
021143a	W Andromedae	181103	RY Ophiuchi
022980	RR Cephei	182306	T Serpentis
043065	T Camelop	183149	SV Draconis
053068	S Camelop	183225	RZ Herculis
054615a	Z Tauri	185634	Z Lyrae
070109	V Canis Minoris	190529a	V Lyrae
071201	RR Monocerotis	190967	U Draconis
083350	X Ursae Majoris	192928	TY Cygni
110506	S Leonis	193509	RV Aquilae
122001	SS Virginis	200812	RU Aquilae
122532	T Canum. Venat.	203611	Y Delphini
124204	RU Virginis	204318	V Delphini
133273	T Ursae Minoris	205017	X Delphini
142205	RS Virginis	210812	R Equulei
151714	S Serpentis	211614	X Pegasi
154536	X Cor. Bor.	*212030*	S Microscopii
155229	Z Cor. Bor.	214024	RR Pegasi
160118	R Herculis	215605	V Pegasi
160210	U Serpentis	220412	T Pegasi
160625	RU Herculis	222129	RV Pegasi
161138	W Cor. Bor.	225914	RW Pegasi
162807	SS Herculis	231508	S Pegasi
170627	RT Herculis	233956	Z Cassiopeiae
171401	Z Ophiuchi	235855	Y Cassiopeiae
171723	RS Herculis		

New Variable 98.1914 Capricorni.—In *A. N.* 4777 Mr. K. Graff gives the results of his observations of the companion star to BD $-9°5356$. The observations seem to indicate that this faint star belongs to the Mira-type of variables, and that it has a range from 10^m to $<12^m.7$.

Observations of Suspected Variables.—In *A. N.* 4778 Mr. G. Harnig from observations made during the years 1909 to 1914, concludes that there is a slight variation in the light of the star 31 Orionis, and also in λ Geminorum; the latter probably has a period of approximately 340 days. Observations of ν Cassiopeiae extending over the same period indicate that this star remained constant during this time.

New Variable 1.1915 Piscium.—In *A. N.* 4780 Mr. Cuno Hoffmeister announces the first variable for this year. The star BD $+ 25°200$ which is given as $8^m.5$ was found on December 6 to be about $1^m.3$ brighter than this, and is therefore considered variable. An interesting note by the editor of the *A. N.* states that the magnitude of this star for 1878.7 was given as 8.4, which is in close agreement with the BD magnitude.

Minima of Variable Stars of Short Period.

[Calculated by Elva Utzinger and at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1915 June							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8			10 21;					
RT Sculptor.	31.5	−26 13	9.6—10.5	0 12.3	1 7;	8 23;	16 15;	24 7				
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	3 4;	10 14;	18 1;	25 11				
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	4 21;	12 8;	19 20;	27 7				
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	6 12;	12 15;	18 18;	30 23				
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	5 22:	13 1;	20 5;	27 8				
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	4 7;	11 4;	18 0;	24 21				
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	7 17;	14 21;	22 1;	29 5				
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	1 15;	10 10;	19 5;	28 0				
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	7 15;	15 13;	23 12					
RX Cassiop.	58.8	+67 11	8.6— 9.1	32 07.6			29 1					
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	4 0;	9 17;	21 5;	26 22				
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	6 10;	13 5;	20 0;	26 19				
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	3 22;	11 20;	19 17;	27 15				
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	7 18;	16 2;	24 9					
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	1 10;	9 7;	17 5;	25 2				
RW Persei	13.3	+42 04	8.8—11.0	15 04.8	2 16;	15 20;	29 11					
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	5 2;	14 13;	23 23					
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1		6 8;	18 18					
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	2 20;	9 12;	16 4;	22 20				
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	4 10;	9 21;	20 19;	26 6				
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	4 14;	10 15;	16 16;	28 17				
SU Tauri	45.8	+28 05	9.4—11.0	2 04.0	1 21;	10 13;	19 5;	27 21				
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	9 17;	20 3;	30 13					
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	8 23;	16 23;	24 23					
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	6 6;	11 23;	23 10;	29 4				
U Columbae	6 11.2	−33 03	9.2—10.0	2 19.2	2 19;	14 0;	25 5;	30 19				
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	3 10;	11 15;	19 20;	28 1				
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	5 3;	12 18;	20 9;	28 0				
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	6 20;	19 1						
RU Monoc.	6 49.4	− 7 28	9.8—10.5	0 21.5	6 4;	13 9;	20 13;	27 17				
R Can. Maj.	7 14.9	−16 12	5.8— 6.4	1 03.3	7 3;	16 5;	25 8					
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	7 16;	16 23;	26 6					
Y Camelop.	27.6	+76 17	9.5—12	3 07.3		10 19;	20 17;	30 15				
TX Gemin.	30.3	+17 8	10.0—11.9	2 19.2	5 20;	14 5;	22 15					
RR Puppis	43.5	−41 08	9.4—10.7	6 10.3	5 16;	12 2;	18 12;	24 23				
V Puppis	7 55.4	−48 58	4.1— 4.8	1 10.9	1 1;	8 7;	22 20;	30 3				
X Carinae	8 29.1	−58 53	7.9— 8.7	0 13.0	7 7;	15 8;	23 11					
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	3 17;	13 4;	22 16					
RX Hydrae	9 0.8	− 7 52	9.1—10.5	2 6.8	5 14;	14 17;	23 20					
S Antliae	27.9	−28 11	6.7— 7.3	0 07.8	5 15;	12 2;	18 14;	25 2				
S Velorum	29.4	−44 46	7.8— 9.3	5 22.4	3 3;	9 1;	15 0;	20 22				
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	2 6;	10 16;	19 2;	27 13				
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	9 17;	19 0;	28 6					
SS Carinae	10 54.2	−61 23	12.2—12.8	3 07.2	7 9;	14 0;	20 15;	27 4				
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	8 19;	17 14;	26 10					
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	1 22;	9 6;	16 14;	23 21				
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	6 13;	13 7;	20 2;	26 21				
RZ Centauri	12 55.6	−64 05	8.5— 8.9	1 21.0	2 15;	10 3;	17 15;	25 3				
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	4 20;	12 7;	19 17;	27 4				
δ Librae	14 55.6	− 8 07	4.8— 6.2	2 07.9	3 23;	10 23;	17 23;	24 22				
U Coronae	15 14.1	+32 01	7.6— 8.7	3 10.9	6 21;	13 19;	20 17;	27 14				
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.4	8 18;	17 4;	25 14					

Minima of Variable Stars of Short Period—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1915 June
	h m	° ′		d h	d h d h d h d h
SS Librae	15 43.4	−15 14	9.3—11.5	0 18.4	8 9; 16 1; 23 17
SW Ophiuchi	16 11.1	− 6 44	9.2—10.0	2 10.7	2 6; 9 14; 16 22; 24 6
SX Ophiuchi	12.6	− 6 25	10.5—11.2	2 01.5	7 14; 15 20; 24 2
R Arae	31.1	−56 48	6.8— 7.9	4 10.2	5 0; 13 21; 22 18
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	6 19; 16 13; 27 13
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	2 23; 9 18; 23 8; 30 3
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	4 10; 12 20; 21 5; 29 14
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	1 18; 7 22; 14 1; 20 5
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	5 9; 12 14; 19 19; 27 0
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	4 7; 11 16; 19 1; 26 10
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	6 0; 14 4; 22 8; 30 13
TX Scorpii	48.6	−34 13	7.5— 8.2	0 22.6	1 13; 9 2; 16 15; 24 4
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	3 10; 11 4; 18 22; 26 16
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	3 15; 11 15; 19 14; 27 14
WX Sagittae	53.6	−17 24	9.2—10.8	2 03.1	5 15; 14 3; 22 16
WY Sagittae	17 54.9	−23 1	9.5—10.6	4 16.0	8 19; 18 3; 27 11
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	9 1; 19 9; 29 17
RS Sagittarii	11.0	−34 08	5.9— 6.3	2 10.0	5 2; 12 8; 19 14; 26 20
V Serpentis	11.1	−15 34	9.5—11.1	3 10.9	4 5; 11 3; 18 1; 24 22
RZ Scuti	21.1	− 9 15	7.4— 8.3	15 03.2	4 6; 19 9
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	8 9; 16 15; 24 21
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	9 4; 18 1; 26 23
SX Sagittarii	39.7	−30 36	8.7— 9.8	2 01.8	5 11; 13 18; 22 2; 30 9
RR Draconis	40.8	+62 34	9.3—13	2 19.9	4 7; 12 19; 21 7; 30 18
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	3 16; 10 7; 23 14; 30 6
β Lyrae	46.4	+33 15	3.4— 4.1	12 21.8	1 9; 14 7; 27 5
U Scuti	18 48.9	−12 44	9.1— 9.6	0 22.9	6 17; 16 6; 25 19
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	5 13; 13 3; 20 17; 28 16
RV Lyrae	12.5	+32 15	11. —12.8	3 14.4	4 15; 11 20; 19 0; 26 5
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	2 1; 11 2; 20 0; 28 23
U Sagittae	14.4	+19 26	6.5— 9.0	3 09.1	7 9; 14 3; 20 22; 27 16
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	2 21; 10 6; 17 14; 24 23
TT Lyrae	24.3	+41 30	9.3—11.6	5 05.8	1 18; 7 0; 17 11; 27 23
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	3 5; 9 18; 16 7; 29 8
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	2 3; 8 3; 20 3; 26 3
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	1 17; 8 8; 21 14; 28 6
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	9 16; 18 20; 27 23
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	7 12; 15 23; 24 9
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	5 12; 12 7; 19 2; 25 21
UW Cygni	19.6	+42 55	10.5—13	3 10.8	3 22; 10 19; 17 17; 24 15
V Vulpec.	32.3	+26 15	8.2—9.8	37 19.0	
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	5 0; 14 15; 24 5
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	8 20; 18 0; 27 5
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	5 12; 13 0; 20 12; 27 23
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	3 15; 9 11; 15 7; 27 0
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	2 6; 12 8; 22 10
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	4 0; 11 10; 18 19; 26 4
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	8 0; 17 16; 27 9
RY Aquarii	14.8	−11 14	8.8—10.4	1 23.2	4 3; 12 0; 19 21; 27 18
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	9 11
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7	3 1; 13 5; 23 8
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	4 13; 9 18; 20 3; 25 7
X Lacertae	22 45.0	+55 54	8.2— 8.6	5 10.6	2 1; 7 12; 12 23; 23 20
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.3	9 2; 17 9; 25 16
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	7 8; 14 21; 22 10; 29 23
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	8 7; 17 13; 24 19

Maxima of Variable Stars of Short Period.

[Calculated by Julia M. Hawkes and Agnes E. Wells at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5h; Central standard time 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1915. June.
	h m	° ′		d h	d h d h d h d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.4	36 13.7	5 13
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	5 18; 13 21; 22 1; 30 4
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	2 11; 10 5; 17 23; 25 17
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	9 22; 24 17
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	6 1; 13 23; 21 22; 29 20
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	2 7; 10 2; 17 21; 25 16
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	5 14; 12 21; 20 3; 27 10
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	8 24
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	2 6; 10 9; 19 9; 27 23
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	8 10; 19 13; 30 16
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0	3 10; 15 1; 26 16
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	7 6; 14 22; 22 14; 30 6
SY Aurigae	05.5	+42 41	8.4— 9.5	10 03.3	2 12; 12 15; 22 18
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	4 11; 12 4; 19 21; 27 14
RZ Gemin.	5 56.6	+22 12	9.1—10.0	5 12.7	2 11; 8 0; 19 1; 30 2
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	1 13; 9 2; 16 16; 24 9
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3	5 15
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	7 16; 14 21; 22 2; 29 7
W Gemin.	6 29.2	+15 24	6.7— 7.5	7 22.0	3 0; 10 22; 18 20; 26 18
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	3 6; 13 10; 23 14
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	22 0
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	4 3; 12 1; 20 0; 27 23
V Carinae	8 26.7	−59 47	7.4— 8.1	6 16.7	1 16; 8 9; 15 1; 28 11
T Velorum	8 34.4	−47 01	7.6— 8.5	4 15.3	5 18; 15 1; 24 8
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	2 9; 11 2; 19 20; 28 14
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 0.0	8
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	4 15; 11 10; 18 5; 24 23
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	5 17; 12 8; 18 22; 25 13
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	10 5; 19 21; 29 13
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	5 16; 13 15; 21 15; 29 14
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	7 11; 14 4; 20 22; 27 15
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	5 5; 11 0; 22 16; 28 12
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	1 2; 10 11; 19 21; 29 6
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5	3 23, 21 5
SS Hydrae	25.0	−23 08	7.4— 8.1	8 4.8	1 14; 9 19; 18 0; 26 5
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	6 18; 13 18; 20 19; 27 19
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	6 16; 14 21; 23 3
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	2 8; 13 7; 18 19; 29 19
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	1 13; 9 2; 16 15; 24 4
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	4 1; 11 11; 28 20; 26 6
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	5 17; 12 12; 19 7; 26 1
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	1 23; 8 7; 14 15; 27 6
S Normae	16 10.6	−57 39	6.6— 7.6	9 18.1	7 15; 17 9; 27 4
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	9 11; 18 7; 27 4
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	2 18; 8 20; 20 23; 27 0
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	1 10; 8 11; 15 11; 29 11
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9	12 15; 29 18
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	2 5; 9 19; 17 9; 24 23
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	4 20; 10 14; 22 3; 27 22
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	5 15; 12 9; 19 2; 25 20
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3	3 16; 14 0; 24 8
Y Lyrae	34.2	+43 52	11.3—12.3	0 12.1	3 11; 9 12; 21 13; 27 14
RZ Lyrae	39.9	+32 42	9.9—11.2	0 12.3	3 19; 9 23; 22 5; 28 8
RT Scuti	18 44.1	−10 30	9.1— 9.7	0 11.9	6 8; 12 7; 24 4; 30 3
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	8 2; 17 4; 26 6

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1915. June.							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	
U Aquilae	19 24.0	− 7 15	6.2— 6.9	7 00.6	8 0;	15 0;	22 1;	29 1				
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	2 8;	9 8;	23 7;	30 7				
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	7 3;	15 2;	23 2					
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	6 18;	14 11;	22 3;	29 20				
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	5 10;	12 15;	19 19;	26 23				
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	3 20;	12 5;	20 15;	29 0				
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	6 5;	12 13;	18 21;	25 4				
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3		11 23;	28 8					
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	5 0;	13 21;	22 19;	27 4				
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	1 17;	8 11;	21 22;	28 15				
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	1 15;	8 8;	15 2;	28 12				
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	1 19;	16 13						
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6		13 2;	20 23;	28 20				
SW Aquarii	10.2	— 0 20	9.9—10.8	0 11.0	1 22;	8 19;	22 14;	29 11				
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	2 4;	11 22;	21 15;	26 12				
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	3 5;	11 20;	20 12;	29 3				
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	9 9;	14 18;	25 11;	30 20				
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	2 11;	13 8;	24 5					
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	5 19;	12 5;	18 15;	25 1				
V Lacertae	22 44.5	+55 48	8.2— 8.9	4 23.6	3 22;	8 21;	18 21;	28 20				
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	5 8;	10 18;	21 15;	27 2				
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	2 0;	8 7;	20 21;	27 4				
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	8 10;	20 14						
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	3 7;	8 7;	18 6;	28 5				

Betelgeuse.—Concerning Mr. Seagrave's note (POP. ASTRON. for April, 1915 page 241), I should like to record that my observations of 054907 α Orionis (Betelgeuse) confirm the decline that he has noticed within the three weeks or so prior to 1915 March 5, and show moreover that the star has continued faint since then. In fact, I have found Betelgeuse unusually faint during most of this season, and have secured 74 estimates to date, extending over the period 1914 July 28 through 1915 April 17. The following tabular résumé of these observations may be of interest:—

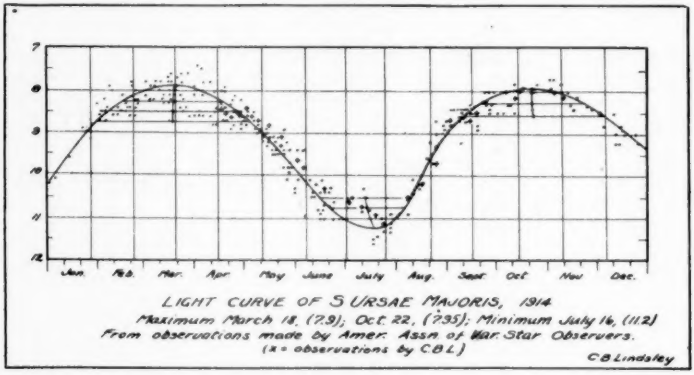
Period	No. of estimates	Mean magnitude
1914 July 28-1914 Nov. 1	23	0.32±
1914 Nov. 3-1915 Jan. 15	23	0.40±
1915 Jan. 16-1915 Apr. 3	23	0.51±
1915 Apr. 11-1915 Apr. 17	5	0.51±

From the foregoing data it is seen that the variable has declined fairly steadily to what may now be expected to be a minimum. Since 1914 December 31, my estimates have never made Betelgeuse brighter than magnitude 0.48, and on two very recent occasions (Apr. 3 and 13) the star has been as faint as magnitude 0.53.

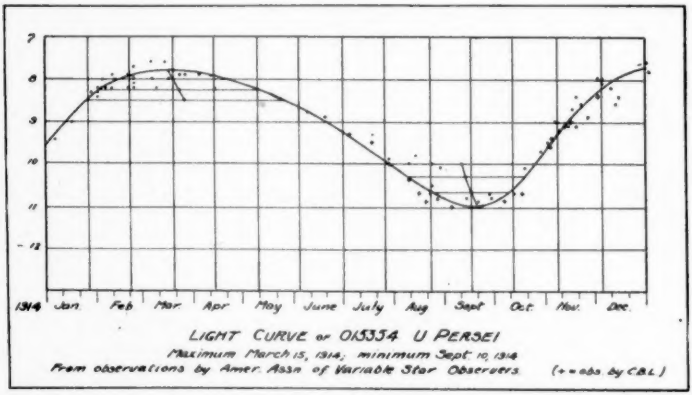
The comparison stars employed in the above observations have been: Capella (0.21), Rigel (0.34), Procyon (0.48), and Aldebaran (1.06). The appended magnitudes are taken from the *Revised Harvard Photometry*.

FREDERICK C. LEONARD.

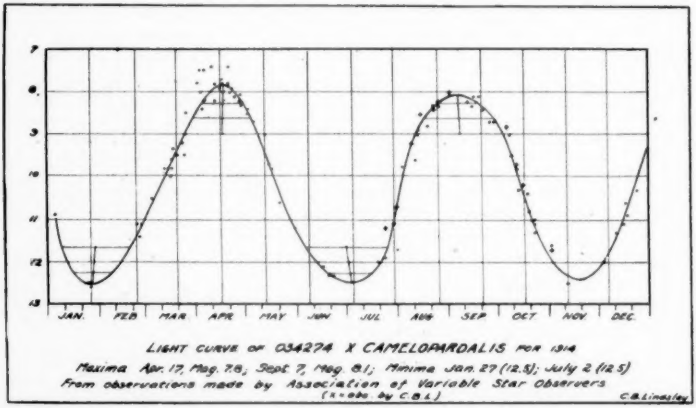
1338 Madison Park, Chicago, Ill.
1915 April 19.



LIGHT CURVE OF S URSAE MAJORIS, 1914.
Maximum March 18, (7.9); Oct. 22, (7.95); Minimum July 16, (11.2)
From observations made by Amer. Assn. of Var. Star Observers.
(x = observations by C.B.L.)
C.B. Lindsley



LIGHT CURVE OF 015334 U PERSEI
Maximum March 15, 1914; minimum Sept. 10, 1914
From observations by Amer. Assn. of Variable Star Observers. (+ = obs. by C.B.L.)



LIGHT CURVE OF 034274 X CAMELOPARDALIS FOR 1914
Maxima Apr. 17, Mag. 7.8, Sept. 7, Mag. 8.1; Minima Jan. 27 (12.5); July 2 (12.5)
From observations made by Association of Variable Star Observers
(x = obs. by C.B.L.)
C.B. Lindsley

COMET AND ASTEROID NOTES.

Third Elements and Ephemeris of Comet 1915 *a* (Mellish).—The results given below were obtained from the following observations made by Aitken:

1915 Gr. M. T.	Comet's Apparent α	δ
	h m s	° ′ ″
Feb. 13.0619	17 06 01.9	+2 59 01
Feb. 27.01932	17 23 43.72	+1 54 50.2
Mar. 19.0207	17 48 49.0	+0 06 24

ELEMENTS.

T = 1915 July 17.42188 Gr.M.T.
ω = 247° 27′ 51″
Ω = 72 23 47 } 1915.0
i = 54 39 30
log q = 0.004932

(O—C)	I	III
cos δΔα	0″	0″
Δδ	+4	0

CONSTANTS FOR THE EQUATOR 1915.0

$x = r$ [9.798553] sin (38° 43′ 07″ + v)
$y = r$ [9.949249] sin (348 05 40 + v)
$z = r$ [9.955031] sin (272 20 34 + v)

EPHEMERIS FOR GREENWICH MEAN MIDNIGHT.

1915	True α	True δ	log Δ	Br.
	h m s	° ′ ″		
Apr. 6.5	18 11 49.0	— 2 34 18	0.1545	6.25
7.5	13 04.3	46 14		
8.5	14 19.7	2 58 39		
9.5	15 35.3	3 11 33		
10.5	16 51.1	24 59	0.1249	7.54
11.5	18 07.1	38 57		
12.5	19 23.4	3 53 31		
13.5	20 39.9	4 08 42		
14.5	21 56.7	24 32	0.0934	9.18
15.5	23 13.9	41 03		
16.5	24 31.5	4 58 18		
17.5	25 49.5	5 16 19		
18.5	27 08.0	35 10	0.0601	11.83
19.5	28 27.0	5 54 53		
20.5	29 46.7	6 15 30		
21.5	31 07.0	37 05		
22.5	32 28.0	6 59 42	0.0245	14.06
23.5	33 49.8	7 23 25		
24.5	35 12.5	7 48 17		
Apr. 25.5	18 36 36.2	— 8 14 22		

1915	True α	True δ	log Δ	Br.
	h m s	° ′ ″		
Apr. 26.5	18 38 00.9	— 8 41 46	9.9866	17.71
27.5	39 26.8	9 10 32		
28.5	40 54.0	9 40 47		
29.5	42 22.6	10 12 36		
Apr. 30.5	43 52.8	10 46 04	9.9461	22.60
May. 1.5	45 24.7	11 21 18		
2.5	46 58.4	11 58 26		
3.5	48 34.2	12 37 34		
4.5	50 12.2	13 18 51	9.9029	29.23
5.5	51 52.6	14 02 25		
6.5	53 35.8	14 48 25		
7.5	55 21.9	15 37 01		
8.5	57 11.4	16 28 23	9.8570	38.32
9.5	18 59 04.5	17 22 42		
10.5	19 01 01.7	18 20 10		
11.5	03 03.4	19 21 00		
12.5	05 10.1	20 25 24	9.8085	50.89
13.5	07 22.4	21 33 36		
14.5	09 41.0	22 45 51		
15.5	12 06.4	24 02 23		
16.5	14 39.7	25 23 27	9.7582	68.20
17.5	17 22.0	26 49 19		
18.5	20 14.4	28 20 11		
19.5	23 18.4	29 56 18		
May 20.5	19 26 35.6	—31 37 51	9.7077	91.55

Brightness February 13 = 1.00.

After May 20 the comet will be too far south for good observation in this latitude. In order that those in the southern hemisphere may have an idea of its apparent path and relative brightness, an approximate ephemeris is here added.

APPROXIMATE EPHEMERIS FOR GREENWICH MEAN MIDNIGHT.

1915	True α	True δ	log Δ	Br.
	h m	°		
May 24.5	19 43	—39.4	9.6599	121.4
May 28.5	20 06	48.6	9.6198	155.4
June 1.5	20 45	58.8	9.5936	186.4
5.5	21 59	68.3	9.5864	204.8
9.5	0 14	73.7	9.5991	205.0
13.5	2 42	72.2	9.6274	190.5
17.5	4 07	66.9	9.6652	169.0
21.5	4 51	61.3	9.7069	147.1
25.5	5 17	56.3	9.7488	126.7
June 29.5	33	52.0	9.7891	109.5
July 3.5	44	48.2	9.8275	94.9
July 7.5	5 53	—45.3	9.8612	83.4

Brightness February 13 = 1.00.

It should be noted that this orbit is based upon three single observations. As no other observations near the last two dates were available, normal places could not be formed, nor could the individual observations be checked up with others.

A comparison of the observation of February 16, upon which the orbits given in Bulletin 268 are based, with this orbit shows $\Delta\alpha \cos\delta = +6''$ and $\Delta\delta = -11''$. The discrepancy of 15″ between this declination and that of Aitken's first observation fully accounts for the large residual in the first declination of the orbit in Bulletin 268, and also for the difference between that orbit and the one given here.

A closer ephemeris after May 20 is not given, as the perturbations due to the action of the earth should be taken into account then, and also because slight changes in the orbit will make large changes in the place of the comet as seen from the earth on account of the very close approach to the earth in June.

A similarity between the elements of this comet and those of the comet 1748 II is noted. Computations to test the possibility of identity of the two are being undertaken here.

R. T. CRAWFORD.

Berkeley Astronomical Department, March 29, 1915.
Lick Observatory Bulletin No. 270.

Spectrum of Comet 1915 *a* (Mellish).—The following night letter comes to hand as we are about to close up the forms for this number of POPULAR ASTRONOMY:—

"The spectrum of Mellish's comet was observed at the Lowell Observatory, with the slit spectrograph April 20, to consist of the usual series of cometary bright bands, but with marked peculiarity and a relatively intense background of continuous, i. e. solar, spectrum of the emission bands. The group about wave length 4040 extends farther from the nucleus and is brighter, while those of hydrocarbon are relatively fainter than in most comets. The cyanogen bands possess an abnormality and the spectrum should be followed at intervals throughout the comet's long period of visibility. A direct photograph of the comet on the same morning shows a tail composed of two divergent branches in position angles 270° and 295°, one and a half and three-fourths degrees long respectively.

LOWELL."

Ephemeris of Comet 1913 *f* (Delavan).

[From *Astronomische Nachrichten* 4786. Greenwich Mean Time.]

1915	α	δ	log *r*	log Δ	M	Aber.
	h m s	° ′			m	m s
May 2	17 11 16	−50 27.4	0.46266	0.32687	7.1	17 38
6	17 2 31	51 30.8				
10	16 53 6	52 27.4				
14	43 9	53 16.5	0.48231	0.33796	7.3	18 6
18	32 48	53 57.6				
22	22 17	54 30.5				
26	11 45	54 55.3	0.50093	0.35747	7.5	18 55
30	16 1 24	55 12.2				
June 3	15 51 25	55 21.8				
7	41 56	55 24.8	0.51862	0.38424	7.7	20 8
11	33 6	55 22.0				
15	25 0	55 14.5				
19	17 41	55 3.0	0.53545	0.41631	7.9	21 40
23	11 11	54 48.6				
27	5 31	54 32.1				
July 1	15 0 38	54 14.2	0.55150	0.45148	8.2	23 30
5	14 56 32	53 55.6				
9	53 10	53 36.8				
13	50 30	53 18.2	0.56682	0.48783	8.5	25 33
17	48 29	53 0.2				
21	47 5	52 43.2				
25	46 13	52 27.4	0.58148	0.52390	8.7	27 46
29	45 52	52 12.8				
Aug. 2	45 59	51 59.7				
6	14 46 33	−51 48.0	0.59553	0.55866	9.0	30 4

Ephemeris of the Periodic Comet Tempel 2.

[From *Astronomische Nachrichten* 4792. 12h Berlin Mean Time.]

1915		True α	True δ	log r	log Δ	$r_0^2\Delta_0^2/r^2\Delta^2$
		h m s	° ′			
May	2	23 45 39	−5 12.5	0.12628	0.25653	1.77
	4	52 9	4 46.8			
	6	23 58 36	4 21.3			
	8	0 5 0	3 55.9			
	10	11 22	3 30.8	0.13144	0.25509	1.74
	12	17 40	3 16.0			
	14	23 54	2 51.4			
	16	30 5	2 17.1			
	18	36 12	1 53.2	0.13826	0.25413	1.69
	20	42 16	1 29.7			
	22	48 17	1 6.6			
	24	0 54 14	0 43.9			
	26	1 0 7	−0 21.6	0.14651	0.25353	1.63
	28	5 57	+0 0.1			
	30	11 43	0 21.5			
June	1	17 26	0 42.2			
	3	23 5	1 2.5	0.15600	0.25305	1.57
	5	28 40	1 22.2			
	7	34 11	1 41.4			
	9	39 38	1 59.9			
	11	45 2	2 17.9	0.16648	0.25243	1.50
	13	50 22	2 35.3			
	15	1 55 37	2 52.0			
	17	2 0 49	3 8.1			
	19	5 56	3 23.6	0.17775	0.25150	1.43
	21	11 0	3 38.4			
	23	15 59	3 52.6			
	25	20 54	4 6.1			
	27	2 25 45	+4 19.0	0.18959	0.25002	1.36

NOTES FOR OBSERVERS.

Monthly Report of the American Association of Variable Star Observers, Mar.-Apr., 1915.

The unprecedented period of fair weather in the Eastern States during the month of March is reflected in the great increase in the number of observations over last month's report.

Mr. Richter continues in the lead as regards the number of estimates contributed. His list this month contains 365 observations, many of them made in the early morning hours, which are of special value.

Messrs. Burbeck, Lacchini, and McAteer also deserve credit for early morning observations. A maximum of the variable 213843 SS Cygni was observed on the 14th of March, and apparently an unobserved and short maximum of the variable 074922 occurred about March 7.

Mr. Richter's estimate of 5.4 magnitude for the variable 154428 R Coronae, on the 19th of March, is of interest. This variable should be closely observed by every member, owing to its irregularity and its liability to a sudden wane which it is hoped will be well observed.

VARIABLE STAR OBSERVATIONS Mar.-Apr. 1915.

001046
X Androm.

Mo.	Day	Est.	Obs.
3	11	11.5	B
	16	10.8	V

001726
T Androm.

Mo.	Day	Est.	Obs.
2	1	9.4	Ly
	7	8.3	Bb
	10	8.9	B

001755
T Cassiop.

Mo.	Day	Est.	Obs.
3	3	8.5	R
	3	8.7	M
	4	8.6	Bu
	8	8.4	R
	9	8.1	B
	11	8.4	R
	13	8.4	R
	14	8.7	R
	15	8.4	R
	16	8.9	Bu
	16	8.6	R
	17	8.4	R
	19	8.4	R
	19	8.1	B
	30	8.1	B

001838
R Androm.

Mo.	Day	Est.	Obs.
3	3	9.3	Ly
	4	9.2	Bu
	11	8.8	B
	16	8.8	Bu

003179
Y Cephei

Mo.	Day	Est.	Obs.
3	10	10.8	Ba

004047
U Cassiop.

Mo.	Day	Est.	Obs.
3	4	9.0	Bu
	9	9.5	B
	13	11.0	Y
	14	11.4	L
	16	9.4	Bu
	19	9.4	B

004435
V Androm.

Mo.	Day	Est.	Obs.
3	4	9.5	Bu
	16	9.2	Bu

004958
W Cassiop.

Mo.	Day	Est.	Obs.
3	9	9.1	B
	10	9.1	Bb
	19	9.1	B
	30	9.1	B

011272
S Cassiop.

Mo.	Day	Est.	Obs.
3	3	8.0	M
	3	7.7	Ly
	3	9.0	R
	4	8.0	Bu
	5	8.8	R
	8	8.9	R
	9	7.9	B
	10	8.0	Ly
	11	8.9	R
	12	8.5	M
	12	8.5	O
	13	8.9	R
	14	8.5	O
	14	8.8	R
	15	9.1	R
	16	7.6	Bu
	16	9.2	R
	17	7.9	M
	17	9.3	R
	19	8.2	B
	19	9.2	R
	30	8.7	B

012350
RZ Persei

Mo.	Day	Est.	Obs.
3	18	10.5	Y

014958
X Cassiop.

Mo.	Day	Est.	Obs.
3	3	10.0	M
	4	9.8	Bu
	9	9.4	B
	12	10.2	M
	13	9.2	Y
	16	10.4	Bu
	17	10.5	M
	19	9.4	B
	30	9.4	B

015254
U Persei

Mo.	Day	Est.	Obs.
3	3	8.5	M
	3	8.5	R
	3	7.9	V
	4	8.6	Bu
	5	8.8	R
	7	8.5	Ly
	8	9.1	R
	11	8.2	B
	11	9.1	R
	12	8.7	M
	13	9.2	R
	14	9.2	R
	15	9.2	R
	16	8.1	V
	16	9.0	R
	16	8.8	Bu
	17	8.8	R
	19	9.1	R
	19	8.1	B

021024
R Arietis

Mo.	Day	Est.	Obs.
3	3	9.4	Pi
	8	8.8	R
	11	9.0	R
	13	8.9	R
	14	9.1	R
	15	9.0	R
	16	9.0	R
	17	9.0	R
	19	9.1	R

021403
o Ceti

Mo.	Day	Est.	Obs.
2	7	3.5	Bb
	10	3.8	Bb
	21	3.7	L
	27	3.8	L
3	1	4.1	Ly
	1	4.0	Bb
	2	4.2	Mu
	3	4.2	Mu
	4	3.9	L
	4	4.3	Mu
	4	4.2	Bu
	5	3.9	R
	5	4.4	Mu
	6	4.0	L
	6	4.4	Mu
	7	4.2	Ly
	7	4.2	Bb
	8	4.0	R
	10	4.6	Mu
	11	4.2	L
	11	4.2	R
	11	4.5	Bb
	12	4.3	L
	13	4.2	R
	13	4.3	Ly
	14	4.4	L
	15	4.3	R
	15	4.8	Mu
	16	4.3	R
	17	4.4	R
	19	4.4	R
	20	4.3	Ly
	20	4.7	Bb
	24	5.0	Bb

021558
S Persei

Mo.	Day	Est.	Obs.
3	1	10.3	Bb
	4	10.2	Bu
	7	10.4	Bb
	7	10.4	Ly
	11	9.2	B
	11	10.5	Bb
	12	10.5	Pi
	13	10.5	R
	14	10.5	R
	14	10.4	Ly
	15	10.3	R
	16	10.2	R
	16	10.2	Bu

S Persei

Mo.	Day	Est.	Obs.
3	17	10.1	R
	19	10.0	R
	20	10.7	Bb
	24	10.7	Bb
	29	9.4	B

022813
U Ceti

Mo.	Day	Est.	Obs.
3	13	7.4	R

023133
R Triang.

Mo.	Day	Est.	Obs.
3	12	10.9	B
	13	11.0	Y

024356
W Persei

Mo.	Day	Est.	Obs.
3	3	9.6	Ly
	3	10.3	R
	4	9.8	Bu
	6	9.8	M
	7	9.8	Ly
	8	10.3	R
	8	9.7	Hy
	11	10.4	R
	12	10.2	L
	12	9.7	O
	13	9.6	Hy
	13	10.4	R
	13	9.9	Pi
	14	10.0	Bl
	14	10.4	R
	15	9.6	Hy
	15	10.4	R
	16	9.6	Bu
	16	10.4	R
	17	10.0	M
	17	10.4	R
	19	10.3	R
	21	10.0	Hy

032043
Y Persei

Mo.	Day	Est.	Obs.
3	3	9.3	M
	3	9.7	R
	4	9.3	Bu
	5	9.2	R
	7	9.5	Ly
	8	8.6	Hy
	8	9.1	R
	11	8.9	B
	11	9.4	R
	13	9.6	R
	13	9.4	Hy
	14	9.6	R
	15	9.7	R
	16	9.7	R
	17	9.5	M
	17	9.7	R
	19	9.2	B
	19	9.6	R
	21	9.4	Hy
	28	9.2	Ba

032335
R Persei

Mo.	Day	Est.	Obs.
3	4	8.3	Bu
	11	8.5	R
	11	8.3	O
	13	8.7	R
	14	8.5	R
	15	8.6	R
	16	8.4	R
	17	9.0	M
	17	8.5	R
	19	8.4	R

033362
U Camelop.

Mo.	Day	Est.	Obs.
3	3	8.8	R
	4	9.0	Bu
	5	8.6	R
	8	8.7	R
	11	8.7	R
	13	8.6	R
	14	8.6	R
	15	8.5	R
	16	8.6	R
	16	9.0	Bu
	17	8.6	R
	19	8.6	R

035915
V Eridani

Mo.	Day	Est.	Obs.
3	3	8.9	R
	5	9.0	R
	8	8.9	Hy
	8	8.9	R
	11	9.0	R
	13	8.7	Hy
	13	8.9	R
	15	8.9	R
	16	8.9	R
	17	8.9	R
	19	8.9	R
	21	8.7	Hy

042215
W Tauri

Mo.	Day	Est.	Obs.
3	4	12.2	B
	10	12.1	Ba
	12	11.4	Y
	13	11.1	M
	15	11.8	B
	19	11.0	Y
	28	10.7	Ba

042209
R Tauri

Mo.	Day	Est.	Obs.
3	4	13.4	B
	9	13.8	B
	10	10.1	Ba
	13	11.6	M
	16	13.5	B

042309
S Tauri

Mo.	Day	Est.	Obs.
3	13	11.0	M

VARIABLE STAR OBSERVATIONS Mar.-Apr., 1915—Continued.

043208
RX Tauri

Mo.	Day	Est.	Obs.
2	7	10.6	Bb
	10	10.6	Bb
3	1	11.0	Bb
	3	11.5	Pi
	4	11.1	B
	4	11.0	Bu
	7	11.2	Bb
	10	11.5	Ba
	11	11.2	Bb
	13	11.4	R
	15	11.6	R
	15	11.5	B
	16	11.4	R
	17	11.5	R
	19	11.5	R
	20	11.4	Bb
	24	11.5	Bb

043274
X Camelop.

Mo.	Day	Est.	Obs.
3	3	9.6	Ly
	3	10.3	R
	4	9.4	Bu
	4	9.9	L
	5	10.4	R
	7	10.1	Ly
	8	10.5	R
	10	10.7	O
	11	10.8	R
	12	10.6	B
	12	11.1	O
	13	10.9	R
	14	11.2	R
	14	11.4	O
	14	11.1	L
	15	11.3	R
	16	11.1	R
	16	10.4	Bu
	17	11.2	R
	19	11.2	R
	29	11.7	B

044617
V Tauri

Mo.	Day	Est.	Obs.
3	4	10.4	Bu
	4	11.8	B
	5	11.0	R
	8	11.3	R
	10	12.0	Ba
	11	11.3	R
	13	11.4	R
	15	11.4	R
	15	12.3	B
	16	11.4	R
	16	10.8	Bu
	17	11.4	R
	19	12.5	Y
	19	11.3	R
	24	11.3	Bu

045307
R Orionis

Mo.	Day	Est.	Obs.
3	5	10.0	Bu
	11	10.0	Y
	12	10.0	O
	16	9.6	Bu
	24	9.2	Bu

045514
R Leporis

Mo.	Day	Est.	Obs.
2	27	9.5	L
3	3	9.5	Pi
	3	9.2	M
	5	9.4	R
	5	9.2	Bu
	8	9.6	R
	11	9.6	R
	12	9.0	Pi
	13	9.7	R
	14	9.0	Ly
	14	9.5	L
	14	9.8	R
	15	8.6	B
	16	9.2	Bu
	17	9.6	R
	19	9.6	R

050003
V Orionis

Mo.	Day	Est.	Obs.
3	3	11.0	Pi
	4	11.2	B
	10	10.8	Ba
	15	10.6	B
	19	10.4	Y
	29	9.8	B

050022
T Leporis

Mo.	Day	Est.	Obs.
3	5	10.5	Bu
	5	10.5	R
	8	10.6	R
	11	10.7	R
	12	11.3	Pi
	12	11.2	Y
	13	10.0	Hy
	13	10.8	R
	13	10.7	Ba
	15	10.8	R
	15	10.3	Hy
	16	10.9	Bu

050953
R Aurigae

Mo.	Day	Est.	Obs.
3	3	9.0	R
	5	9.5	Bu
	5	9.0	R
	7	8.3	Ly
	8	9.0	R
	11	8.9	R
	12	8.5	B
	12	9.4	M
	13	8.8	R

R Aurigae

Mo.	Day	Est.	Obs.
3	13	8.5	Ba
	13	8.3	Pi
	14	8.9	R
	14	8.5	Ly
	14	8.5	Bl
	15	8.9	R
	16	9.9	Bu
	16	8.7	R
	17	9.6	M
	17	8.9	R
	18	8.2	Pi
	19	8.7	R
	29	8.5	B

052034
S Aurigæ

Mo.	Day	Est.	Obs.
3	7	9.0	M
	12	8.9	L
	12	8.6	B
	13	8.2	Ba
	17	9.0	M
	29	8.5	B

052036
W Aurigae

Mo.	Day	Est.	Obs.
3	17	11.4	M

052404
S Orionis

Mo.	Day	Est.	Obs.
3	5	10.4	Bu
	10	12.6	Ba
	11	12.4	Y
	13	9.8	M
	16	10.6	Bu
	20	9.7	M

053005
T Orionis

Mo.	Day	Est.	Obs.
3	3	10.0	Pi
	3	10.2	Ly
	4	11.0	B
	5	10.4	Bu
	7	10.1	Ly
	8	10.0	Pi
	10	9.9	Ba
	10	10.0	Pi
	12	9.7	Pi
	12	9.5	E
	13	9.8	M
	14	9.9	Ly
	14	9.7	L
	15	9.8	B
	16	10.8	Bu
	20	9.9	M
	30	11.0	B

053531
U Aurigae

Mo.	Day	Est.	Obs.
3	11	13.1	B
	17	12.0	M

054319
SU Tauri

Mo.	Day	Est.	Obs.
3	12	9.5	Y

054615
RU Tauri

Mo.	Day	Est.	Obs.
3	12	11.6	Y

054615
Z Tauri

Mo.	Day	Est.	Obs.
3	12	12.0	Y

054974
V Camelop.

Mo.	Day	Est.	Obs.
3	12	10.4	B
	29	9.9	B

054920
U Orionis

Mo.	Day	Est.	Obs.
3	4	9.6	S
	9	9.3	Bu
	10	9.1	Ba
	12	9.5	M
	13	8.5	Hr
	13	9.0	Pi
	14	9.7	Bl
	16	9.0	Bu
	24	8.6	Bu

055353
Z Aurigae

Mo.	Day	Est.	Obs.
3	13	10.6	Pi
	15	10.3	Y
	26	9.6	M

060124
S Leporis

Mo.	Day	Est.	Obs.
3	5	6.7	R
	8	6.2	R
	11	6.5	R
	13	6.5	R
	14	6.5	R
	15	6.5	R
	16	6.4	R
	17	6.3	R
	19	6.4	R

060450
X Aurigae

Mo.	Day	Est.	Obs.
2	21	9.9	L
3	3	10.7	V
	9	10.8	Bu
	10	11.3	Ba
	12	11.4	L
	12	11.3	B
	13	12.3	Ba
	15	11.5	Y
	16	11.7	B
	27	9.7	M
	29	12.6	B

060547
SS Aurigae

Mo.	Day	Est.	Obs.
3	13	11.4	Hr

061647
V Aurigae

Mo.	Day	Est.	Obs.
3	12	9.9	B
	13	10.3	Ba
	13	10.6	Y
	19	10.3	B

061702
V Monoc.

Mo.	Day	Est.	Obs.
3	8	7.5	Pi
	13	8.0	Ba
	15	8.2	Pi

061907
T Monoc.

Mo.	Day	Est.	Obs.
3	4.5	6.8	Bu
	5.5	6.7	Bu
	6.5	6.6	Bu
	8.5	6.4	Bu
	9.5	6.3	Bu
	12.5	6.0	Bu
	13.5	6.0	Bu
	22.5	6.4	Bu
	25.5	6.5	Bu
	29.5	6.7	Bu

063159
U Lyncis

Mo.	Day	Est.	Obs.
3	12	12.6	Y
	12	13.8	B
	13	14.0	Ba

063558
S Lyncis

Mo.	Day	Est.	Obs.
3	9	9.6	Bu
	12	9.5	B
	13	10.0	Hr
	13	9.7	Ba
	20	9.6	Bu
	29	10.0	B

064030
X Gemin.

Mo.	Day	Est.	Obs.
3	8	9.7	V
	9	9.0	Bu
	12	9.9	L
	13	9.5	Ba
	15	9.8	Y
	16	9.9	V
	20	9.4	Bu

064932
Nova Gemin. II

Mo.	Day	Est.	Obs.
2	7	12.0	Bb
	10	12.0	Bb
3	1	12.3	Bb
	7	12.2	Bb
	11	12.3	Bb
	12	11.7	L
	14	11.8	L
	20	12.5	Bb
	24	12.3	Bb

VARIABLE STAR OBSERVATIONS Mar.-Apr., 1915—Continued.

065111
Y Monoc.

Mo.	Day	Est.	Obs.
3	8	10.6	V
	11	10.7	Y
	13	10.2	Ba
	16	9.9	V
	19	9.8	Y

065208
X Monoc.

Mo.	Day	Est.	Obs.
3	8	9.3	Hy
	9	8.8	Bu
	11	9.6	R
	13	9.7	R
	13	9.4	Ba
	13	9.3	Hy
	14	9.7	R
	14	9.4	L
	15	9.3	Hy
	15	9.7	R
	16	9.8	R
	17	8.9	Ma
	17	9.8	R
	19	9.8	R
	20	9.2	Bu
	20	9.8	Hy
	21	9.9	Hy
	22	9.8	Hy

065355
R Lyncis

Mo.	Day	Est.	Obs.
3	5	8.8	R
	8	8.7	R
	9	7.5	Bu
	11	8.5	R
	12	8.2	B
	13	8.3	R
	14	8.4	R
	15	8.4	R
	16	8.3	R
	17	8.4	R
	19	8.3	R
	20	7.3	Bu
	29	8.2	B

065820
ζ Gemin.

Mo.	Day	Est.	Obs.
2	22.7	3.7	R
3	5.7	3.8	R
	8.7	3.9	R
	11.7	3.4	R
	12.6	3.9	R
	13.7	3.9	R
	14.6	3.8	R
	15.7	3.9	R
	16.7	4.1	R
	19.7	3.8	R
	20.7	3.7	R

070122
TW Gemin.

Mo.	Day	Est.	Obs.
3	12	7.8	M
	15	8.1	Hy
	20	7.8	Hy
	21	8.0	Hy
	22	8.2	Hy

070122a
R Gemin.

Mo.	Day	Est.	Obs.
3	11	11.6	Y
	15	12.0	B
	29	12.3	B

070310
R Can. Min.

Mo.	Day	Est.	Obs.
3	4	10.0	B
	4	10.6	L
	12	10.4	O
	13	10.6	Pi
	14	11.2	M
	15	9.8	B

071713
V Gemin.

Mo.	Day	Est.	Obs.
3	11	12.7	Y
	16	13.4	E

072708
S Can. Min.

Mo.	Day	Est.	Obs.
2	7	7.4	Bb
	10	7.6	Bb
3	3	8.4	R
	3	8.2	Ly
	4	8.1	Pi
	5	8.2	R
	5	7.8	B
	8	8.4	R
	8	8.1	Hy
	9	8.5	Bu
	9	8.2	M
	10	8.5	E
	10	8.5	O
	10	8.2	Ly
	11	8.4	R
	12	8.4	M
	12	8.5	O
	13	8.5	R
	13	8.2	Hy
	14	8.6	L
	14	8.5	M
	14	8.4	R
	14	8.4	Ly
	14	8.6	Bl
	15	8.5	Pi
	15	8.5	O
	15	8.4	R
	15	8.3	B
	15	8.1	Hy
	16	8.6	Ly
	16	8.5	R
	17	8.8	M
	17	8.7	Ma

072708
S Can. Min.

Mo.	Day	Est.	Obs.
	17	8.6	R
	19	8.7	R
	20	9.0	Bu
	20	8.8	Hy
	20	8.7	O
	21	8.8	Hy
	22	8.8	Hy
4	2	9.3	O

072811
T Can. Min.

Mo.	Day	Est.	Obs.
3	9	11.4	M
	9	11.2	B
	10	11.0	O
	11	11.8	Y
	12	11.6	E
	16	11.7	B

073508
U Can. Min.

Mo.	Day	Est.	Obs.
3	4	10.1	B
	9	11.0	Bu
	10	10.7	O
	11	10.6	Y
	13	10.9	Pi
	14	10.8	M
	14	10.8	L
	14	10.9	O
	14	10.5	Bl
	15	10.8	B
	17	10.7	E
	20	11.4	Bu

073723
S Gemin.

Mo.	Day	Est.	Obs.
3	13	13.5	M
	15	13.8	B

074323
T Gemin.

Mo.	Day	Est.	Obs.
3	8	9.8	R
	8	9.2	V
	9	10.2	Bu
	11	10.0	R
	12	9.8	M
	12	10.0	O
	13	10.2	R
	14	10.2	R
	15	10.2	R
	15	10.4	Y
	15	10.0	Hy
	16	10.1	O
	16	10.2	R
	17	10.1	V
	17	10.3	R
	19	10.3	R
	20	10.6	Bu
	20	10.0	Hy
	21	9.8	Hy
	22	9.9	Hy

074922
U Gemin.

Mo.	Day	Est.	Obs.
3	4.5	11.5	Pi
	9.5	10.5	Bu
	10.5	11.1	Ba
	10.5	11.2	O
	10.6	11.4	E
	11.5	11.7	E
	11.5	12.1	Ba
	12.2	12.1	L
	12.3	12.4	L
	12.5	11.3	M
	12.5	11.7	Pi
	12.6	12.6	E
	13.5	13.5	Ba
	13.5	11.5	Pi
	16.5	13.8	B
	19.5	13.8	B

081112
R Cancri

Mo.	Day	Est.	Obs.
3	9	9.6	Bu
	9	8.9	M
	10	9.3	O
	10	9.3	E
	12	8.7	M
	13	8.9	Hy
	14	8.9	L
	15	9.5	Hy
	20	9.3	Bu
	20	8.9	O
	21	9.5	Hy
	22	9.5	Hy
	29	9.0	Bu

081617
V Cancri

Mo.	Day	Est.	Obs.
3	9	10.6	Bu
	9	9.3	M
	10	9.8	E
	10	9.4	O
	12	9.4	O
	12	9.2	Y
	13	9.2	Hy
	15	9.3	O
	15	8.8	Hy
	20	10.2	Bu
	20	9.1	O
	21	9.0	Hy
	22	9.3	Hy
4	2	9.0	Bb

081733
T Lyncis

Mo.	Day	Est.	Obs.
3	9	9.5	M
	17	9.7	M

082405
RT Hydrae

Mo.	Day	Est.	Obs.
3	4	8.6	Pi
	9	8.8	Bu
	12	8.6	Pi
	13	8.8	O

RT Hydrae

Mo.	Day	Est.	Obs.
	14	8.7	L
	15	8.6	B
	15	8.9	Pi
	20	9.2	Bu
	20	8.5	O

084803
S Hydrae

Mo.	Day	Est.	Obs.
3	4	8.8	Pi
	5	8.7	R
	7	8.5	Ly
	8	8.6	R
	8	8.8	Pi
	10	8.7	E
	10	8.3	O
	11	8.5	R
	12	8.2	Bu
	12	8.4	Pi
	12	8.7	O
	13	8.6	R
	14	8.3	Ly
	14	8.6	R
	14	8.9	O
	15	8.5	R
	15	8.2	B
	15	8.2	Pi
	16	7.9	O
	16	8.5	R
	17	8.3	Ma
	17	8.4	R
	18	8.1	Ly
	19	8.3	R
	20	7.9	O
	20	8.0	Bu
4	2	7.8	O

085008
T Hydrae

Mo.	Day	Est.	Obs.
3	10	8.3	E
	12	8.6	M
	12	7.7	Bu
	13	8.3	O
	14	8.4	L
	16	8.0	R
	19	8.4	R
	20	7.5	Bu
	20	8.2	O

085120
T Cancri

Mo.	Day	Est.	Obs.
3	14	9.7	L
	18	9.0	B

090425
W Cancri

Mo.	Day	Est.	Obs.
3	10	12.6	E
	12	13.2	Y
	13	13.7	Ba
	18	13.5	B

VARIABLE STAR OBSERVATIONS Mar.-Apr., 1915—Continued.

093014
X Hydrae

Mo.	Day	Est.	Obs.
3	8	11.4	Pi
	12	11.4	Pi
	15	11.2	Pi
	16	10.2	Y
	17	11.1	E

093178
Y Draconis

Mo.	Day	Est.	Obs.
3	13	13.5	Y

093934
R Leo. Min.

Mo.	Day	Est.	Obs.
3	3	8.4	Ly
	4	8.6	Pi
	5	8.8	R
	5	8.6	Bu
	8	8.7	Hy
	8	9.0	R
	9	8.4	M
	10	8.8	E
	10	8.7	Ly
	11	9.0	R
	11	8.7	O
	13	8.1	Hy
	13	9.0	R
	14	8.7	M
	14	8.9	R
	14	8.5	Bl
	14	8.8	O
	15	9.1	Bu
	15	9.0	R
	15	8.3	Hy
	16	9.0	R
	16	9.0	Pi
	17	9.1	R
	18	9.1	Ly
	19	8.9	R
	20	9.0	Hy
	20	7.3	S
	20	8.8	O
	21	9.0	Hy
	22	9.0	Hy
	23	8.9	O
4	6	9.0	S

094211
R Leonis

Mo.	Day	Est.	Obs.
3	3	7.2	Ly
	3	6.6	R
	4	8.0	Mu
	4	7.5	Pi
	5	6.8	R
	5	8.2	Bu
	8	7.5	Hy
	8	6.9	R
	9	7.3	Sp
	9	7.9	B
	9	8.0	M
	10	8.2	E
	11	7.5	O
	11	7.0	R
	12	7.2	Sp
	13	7.5	Hy
	13	7.0	Ba

R Leonis

Mo.	Day	Est.	Obs.
3	13	7.4	R
	14	8.4	Bl
	14	7.5	R
	14	8.9	L
	14	7.5	O
	14	7.9	Mu
	14	8.1	M
	15	8.6	Bu
	15	7.6	R
	15	7.5	Hy
	15	7.5	Pi
	16	7.7	O
	16	7.7	B
	17	8.2	Ma
	17	7.7	R
	18	7.5	Ly
	19	8.2	R
	19	7.9	Mu
	20	7.6	Hy
	20	8.0	O
	20	8.2	S
	21	7.7	Hy
	22	7.7	Hy
	23	8.4	O
4	2	8.5	O
	6	8.6	S

094622
Y Hydrae

Mo.	Day	Est.	Obs.
3	12	7.1	Pi
	16	7.3	R
	19	7.1	R

095421
V Leonis

Mo.	Day	Est.	Obs.
3	5	8.6	Bu
	8	8.6	Y
	8	8.4	V
	9	8.5	B
	9	8.9	Sp
	10	9.0	E
	10	8.6	O
	12	8.8	O
	12	8.6	Sp
	13	8.7	Sp
	14	8.5	O
	14	9.0	M
	15	8.7	Sp
	15	8.4	Bu
	16	8.8	O
	17	9.0	V
	18	8.7	Sp
	20	9.1	O
	23	9.2	O
4	2	10.2	O

103212
U Hydrae

Mo.	Day	Est.	Obs.
3	12	4.9	L

103769
R Urs. Maj.

Mo.	Day	Est.	Obs.
2	7	7.3	Bb
	10	7.3	Bb
3	1	7.4	Bb
	3	7.0	Pi
	3	7.4	R
	3	7.3	Ly
	3	6.7	M
	5	7.1	R
	5	7.5	Bu
	7	7.5	Bb
	8	7.4	R
	8	7.5	Hy
	8	7.0	M
	9	7.1	M
	10	7.0	Pi
	10	7.4	Ly
	11	7.2	M
	11	7.3	R
	11	7.5	O
	11	7.5	Bb
	12	7.0	E
	13	7.2	O
	13	7.5	R
	13	7.0	Hy
	13	7.5	O
	14	7.5	Bl
	14	7.6	Ly
	14	7.3	R
	14	7.3	M
	15	7.5	Hy
	15	7.4	O
	15	7.5	Pi
	15	7.2	R
	15	7.8	Bu
	16	7.1	R
	17	7.4	M
	17	7.5	Ma
	17	7.1	R
	18	7.5	Ly
	19	7.1	R
	20	7.7	Bb
	20	6.9	B
	20	6.8	S
	20	8.0	O
	20	7.6	Hy
	21	7.8	Hy
	22	7.7	Hy
	23	7.9	O
	24	7.7	Bb
	26	7.5	M
4	2	8.1	O
	2	7.7	S

104620
V Hydrae

Mo.	Day	Est.	Obs.
3	12	7.5	Pi
	14	7.2	L
	15	8.0	Y
	21	7.2	Hy
	22	7.0	Hy

104814
W Leonis

Mo.	Day	Est.	Obs.
3	9	13.5	B
	16	11.6	M

115919
R Comae

Mo.	Day	Est.	Obs.
3	14	10.9	M

120012
SU Virginis

Mo.	Day	Est.	Obs.
3	8	9.6	V
	11	9.3	M
	16	9.4	M
	17	9.7	V
	19	10.7	B
	20	9.7	Bu

120905
T Virginis

Mo.	Day	Est.	Obs.
3	8	9.9	V
	9	9.7	Sp
	12	9.8	Sp
	13	9.6	Pi
	15	9.6	Sp
	16	9.8	M
	17	9.9	V
	18	9.6	Sp
	18	10.0	B
	19	9.4	Y

121418
R Corvi

Mo.	Day	Est.	Obs.
3	9	11.4	Sp
	12	11.3	Sp
	13	11.2	Sp
	14	10.8	R
	15	11.2	Sp
	16	11.0	R
	16	11.4	M
	18	11.1	Sp
	19	11.3	B
	19	11.2	Y
	20	10.9	M
	20	10.4	Bu

122001
SS Virginis

Mo.	Day	Est.	Obs.
3	16	7.8	M
	18	7.0	B

122532
T Can. Ven.

Mo.	Day	Est.	Obs.
3	16	8.8	M

123160
T Urs. Maj.

Mo.	Day	Est.	Obs.
3	3	9.4	Pi
	5	9.6	Bu
	8	9.4	M
	9	9.5	M
	9	9.5	Sp
	10	9.8	Pi
	10	9.6	Ly
	10	9.7	Ba
	11	10.0	R

T Urs. Maj.

Mo.	Day	Est.	Obs.
3	11	9.8	O
	11	9.8	E
	11	9.8	M
	12	10.0	M
	12	9.6	Sp
	13	9.8	B
	13	9.6	Sp
	13	10.2	R
	14	10.0	Bl
	14	10.6	R
	14	9.9	O
	15	9.7	Sp
	15	10.3	R
	15	9.8	Bu
	15	9.8	Pi
	16	10.2	M
	16	10.2	R
	16	10.0	O
	17	10.1	R
	18	9.8	Ly
	19	10.3	R
	20	10.6	S
	20	10.1	B
	21	9.8	Hy
	22	9.9	Hy
	23	10.8	O
	25	10.7	M
	28	10.9	Ba
	30	11.3	B

123307
R Virginis

Mo.	Day	Est.	Obs.
2	21	10.0	L
3	8	9.0	Pi
	9	8.8	Sp
	9	9.0	M
	12	8.4	Sp
	15	8.2	O
	15	8.3	Sp
	16	8.0	M
	16	7.9	L
	18	7.8	B
	20	8.4	Bu

123459
RS Urs. Maj.

Mo.	Day	Est.	Obs.
3	5	11.4	Bu
	9	10.5	M
	10	10.3	Ba
	10	10.2	Pi
	12	10.4	M
	13	10.0	Ba
	14	10.2	M
	15	11.6	Bu
	15	10.2	Pi
	16	9.9	M
	17	9.8	M
	18	10.6	Y
	25	9.3	M
	26	9.2	M
	28	10.1	Ba

VARIABLE STAR OBSERVATIONS Mar.-Apr., 1915—Continued.

123961
S Urs. Maj.

Mo.	Day	Est.	Obs.
3	9	11.3	M
	9	11.4	Sp
	10	11.5	Ly
	10	11.3	Ba
	12	11.1	M
	12	11.5	Sp
	13	11.5	B
	13	11.7	Sp
	14	11.0	L
	15	11.4	Sp
	16	10.9	M
	20	10.9	B
	21	10.0	Hy
	22	9.9	Hy
	25	10.3	M
	28	10.1	Ba
	30	9.5	B
4	2	9.7	O
	6	9.8	S

124204
RU Virginis

3	9	13.2	B
	16	13.3	B

124606
U Virginis

2	21	7.6	L
3	9	8.0	M
	16	8.2	M
	16	8.2	L
	20	8.2	B

132202
V Virginis

3	18	12.9	B

132422
R Hydrae

2	21	5.9	L
3	16	5.7	L

132706
S Virginis

2	21	7.4	L
3	9	8.2	M
	12	8.4	Pi
	12	8.2	R
	12	8.2	L
	13	8.3	M
	14	8.5	R
	16	8.6	R
	18	8.5	M
	19	8.9	R
	20	9.2	Bu

134440
R Can. Ven.

3	5	7.2	Bu
	9	7.9	M
	10	7.9	Pi
	10	7.9	Ly
	10	7.8	E
	13	8.3	Ba

R Can. Ven.

3	13	7.8	B
	15	8.3	O
	15	7.6	R
	15	7.0	Bu
	16	8.0	M
	16	7.6	R
	16	7.5	Pi
	18	7.5	Ly
	19	7.7	R
	20	7.9	B
	26	8.3	M

141567
U Urs. Min.

3	1	8.5	Ly
	5	9.2	Bu
	13	8.9	B
	15	9.4	Bu
	20	9.0	S
	20	8.9	B
4	2	9.1	S

141954
S Boötis

3	4	10.5	S
	9	10.9	M
	10	10.9	Ly
	12	10.3	R
	14	11.1	O
	14	10.1	R
	16	11.6	R
	16	11.5	Pi

142539
V Boötis

3	4	7.5	Pi
	9	7.6	M
	9	7.4	Sp
	10	7.5	Pi
	10	7.5	Ly
	12	7.3	Sp
	14	7.9	R
	15	7.5	Pi
	15	8.0	R
	16	7.9	R
	16	7.4	L
	18	7.4	Ly
	19	7.9	R
	20	8.0	Bu
	20	7.8	B
	26	8.0	M
	27	7.5	Pi

142584
R Camelop.

3	4	11.5	L
	12	12.5	Y
	18	12.5	B

143227
R Boötis

3	9	7.9	M
	13	7.5	Pi
	16	7.0	L
	17	7.3	R
	20	7.8	B
	20	7.3	R
	27	7.4	Pi
4	6	7.4	S

144918
U Boötis

3	9	10.3	M
	9	10.3	Sp
	12	10.3	Sp
	13	10.6	M
	15	10.4	Sp
	20	10.4	B

150018
RT Librae

3	18	11.8	M

151520
S Librae

2	21	10.2	L

151714
S Serpentis

3	12	12.1	L

151731
S Cor. Bor.

3	9	7.0	M
	9	6.8	Sp
	12	6.5	R
	13	7.1	M
	13	7.1	Pi
	14	6.4	R
	16	6.8	R
	18	7.2	M
	19	6.8	R
	20	7.4	Bu

151822
RS Librae

2	21	7.9	L
3	16	8.5	L

152714
RU Librae

3	14	11.6	R
	16	11.6	R
	19	11.6	R

153378
S Urs. Min.

3	4	10.5	Pi
	5	9.9	Bu
	10	10.5	Pi
	13	9.5	B
	13	8.6	M
	14	10.0	L
	15	9.5	Bu
	20	9.7	B

154428
R Cor. Bor.

2	7.5	6.0	Bb
	10.5	5.9	B
3	1.5	6.1	Bb
	7.5	6.0	Bb
	7.6	6.0	Ly
	8.9	6.0	E
	9.6	5.8	Bl
	9.9	6.1	E
	10.7	5.6	M
	11.5	6.0	Bb
	12	6.1	Pi
	12.0	5.8	R
	12	6.0	L
	12.6	6.1	Ly
	12.7	5.8	M
	14.0	6.0	R
	14.6	6.1	Ly
	14.8	6.0	Bl
	16.9	5.9	R
	19.9	5.4	R
	20.5	5.6	Bb
	20.6	6.2	Bu
	24.5	5.6	Bb

154536
X Cor. Bor.

3	10	11.2	M

154539
V Cor. Bor.

3	10	8.5	M
	13	8.4	M

154615
R Serpentis

3	9	7.4	M
	9	8.2	E
	13	7.5	M
	14	7.7	R
	16	8.0	R
	18	7.9	M
	19	7.8	R

160210
U Serpentis

3	14	12.3	M

160625
RU Herculis

3	10	8.2	M
	13	8.4	M
	18	8.6	M

162119
U Herculis

3	9	10.3	E
	10	10.5	Sp
	10	10.5	M
	12	10.4	M
	14	9.8	R
	17	9.8	R
	17	10.0	M
	19	9.5	R

162807
SS Herculis

3	12	11.9	L

163137
W Herculis

3	13	12.4	M
	21	11.9	M

163172
R Urs. Min.

3	9	10.4	M
	13	9.7	B
	13	10.5	M
	14	10.0	R
	14	10.2	Ly
	15	9.9	R
	16	10.0	R
	19	10.0	R
	20	9.7	B

163266
R Draconis

3	9	11.0	E
	10	11.2	Sp
	13	11.2	Sp
	15	11.3	Sp
	18	11.3	Sp

164055
S Draconis

3	9	8.2	M
	13	8.6	M
	18	8.9	M

164715
S Herculis

3	9	9.5	E
	10	9.9	M
	13	9.3	Sp
	13	9.7	M
	18	9.4	M

165631
RV Herculis

3	10	13.1	Sp
	13	13.3	Sp
	13	13.6	M
	14	13.4	Sp
	15	13.5	Sp
	18	13.6	Sp
	21	14.0	M

170215
RU Ophiuchi

3	18	11.5	M

171333
u Herculis

3	12	5.2	R
	14	5.3	R
	17	5.2	R
	19	5.2	R

VARIABLE STAR OBSERVATIONS Mar.-Apr., 1915.—Continued.

171723
RS Herculis

Mo.	Day	Est.	Obs.
3	12	7.8	L

172809
RU Ophiuchi

Mo.	Day	Est.	Obs.
3	18	11.3	M

175458
T Draconis

Mo.	Day	Est.	Obs.
3	10	11.2	M
	10	11.2	Sp
	13	11.3	Sp
	15	11.3	Sp
	18	11.2	Sp
	20	11.0	Bu

180565
W Draconis

Mo.	Day	Est.	Obs.
3	10	11.9	Sp
	13	11.8	Sp
	15	11.7	Sp
	18	11.8	Sp

180531
T Herculis

Mo.	Day	Est.	Obs.
3	13	7.8	M
	14	7.7	R
	17	7.9	R
	20	7.9	R

181136
W Lyrae

Mo.	Day	Est.	Obs.
3	8	9.3	E
	9	10.0	M
	12	8.8	R
	13	10.1	M
	14	9.6	R
	17	10.1	R
	18	10.2	M
	20	9.2	Bu
	20	10.2	R
	25	10.5	M

183308
X Ophiuchi

Mo.	Day	Est.	Obs.
3	8	8.8	E
	12	8.6	L
	13	8.1	M

184205
R Scuti

Mo.	Day	Est.	Obs.
2	21.6	5.1	L
3	12.6	5.2	L
	14.0	4.8	R
	14.8	5.5	Bl
	16.6	5.3	L
	17.0	4.8	R
	20.0	4.8	R

184633
β Lyrae

Mo.	Day	Est.	Obs.
3	12.0	3.7	R
	14.0	3.9	R
	17.0	3.9	R

185243
R Lyrae

Mo.	Day	Est.	Obs.
3	20.0	4.3	R

190108
R Aquilae

Mo.	Day	Est.	Obs.
3	12	10.6	L
	17	10.4	M

190926
X Lyrae

Mo.	Day	Est.	Obs.
3	12	9.5	R
	13	9.2	M
	14	9.2	R
	17	9.8	R
	20	9.8	R

193449
R Cygni

Mo.	Day	Est.	Obs.
3	9	10.6	M
	13	10.5	M
	17	10.3	M
	20	10.1	R
	21	9.8	M
	27	9.0	M

193732
TT Cygni

Mo.	Day	Est.	Obs.
3	13	8.0	M
	14	7.9	R
	14	8.0	Bl
	16	7.1	L
	17	7.8	R
	18	8.2	M
	20	7.8	R

194048
RT Cygni

Mo.	Day	Est.	Obs.
3	9	8.3	M
	13	8.0	M
	17	7.8	M
	21	7.6	M
	27	7.2	M

194348
TU Cygni

Mo.	Day	Est.	Obs.
3	9	11.4	M
	13	11.1	M
	17	10.9	M
	21	10.7	M
	27	9.8	M

194604
X Aquilae

Mo.	Day	Est.	Obs.
3	17	10.0	M

194632
χ Cygni

Mo.	Day	Est.	Obs.
3	9	8.2	M
	12	9.0	R
	13	8.5	M
	14	8.9	R
	14	8.5	Bl
	16	8.7	L
	17	9.1	R
	18	8.6	M
	20	8.8	R

195116
S Sagittae

Mo.	Day	Est.	Obs.
3	14.0	5.7	R
	17.0	5.7	R
	20.0	5.3	R

195849
Z Cygni

Mo.	Day	Est.	Obs.
3	9	10.1	M
	13	10.0	M
	21	9.7	M
	27	9.5	M

200647
SV Cygni

Mo.	Day	Est.	Obs.
3	9	8.0	M
	12	9.3	R
	14	9.3	Bl
	14	9.4	R
	14	8.8	M
	17	9.3	R
	20	9.3	R

200715a
S Aquilae

Mo.	Day	Est.	Obs.
3	17	9.8	M
	17	9.8	R
	20	9.7	R

200715b
RW Aquilae

Mo.	Day	Est.	Obs.
3	17	9.3	M
	17	8.7	R
	18	9.4	M
	20	9.1	R

200916
R Sagittae

Mo.	Day	Est.	Obs.
3	17	9.5	R
	18	9.6	M
	20	9.5	R

200938
RS Cygni

Mo.	Day	Est.	Obs.
3	14	8.1	M
	17	7.5	R
	18	8.3	M
	20	7.3	R

201647
U Cygni

Mo.	Day	Est.	Obs.
3	9	9.0	M
	14	10.5	Bl
	14	10.0	R
	14	9.2	M
	16	10.4	L
	17	10.0	R
	20	9.9	R

202539
RW Cygni

Mo.	Day	Est.	Obs.
3	9	7.9	M
	13	8.8	M
	14	8.9	Bl
	14	9.0	M
	17	8.4	M
	18	8.5	M

202946
SZ Cygni

Mo.	Day	Est.	Obs.
3	9	9.3	M
	12	9.8	R
	14	9.3	R
	14	9.8	M
	17	9.7	M
	17	9.4	R
	18	9.6	M
	20	9.9	R

203847
V Cygni

Mo.	Day	Est.	Obs.
3	21	11.8	M

210868
T Cephei

Mo.	Day	Est.	Obs.
3	14	9.5	L
	18	9.4	M
	20	9.5	Bu

213244
W Cygni

Mo.	Day	Est.	Obs.
2	21	5.8	L
3	12	5.8	L
	14	6.4	R
	17	6.3	R
	20	6.3	R

213678
S Cephei

Mo.	Day	Est.	Obs.
3	18	10.8	M

213753
RU Cygni

Mo.	Day	Est.	Obs.
3	13	8.8	M

213843
SS Cygni

Mo.	Day	Est.	Obs.
2	21.6	12.1	L
3	8.9	11.5	E
	9.9	11.7	E
	9.9	12.0	M
	12.6	11.8	L
	13.9	10.8	M
	14.0	8.6	R
	14.9	8.3	M
	16.6	8.3	L
	16.9	8.5	R
	17.9	8.3	M
	18.9	8.6	M
	20.0	9.1	R
	21.8	9.5	M
	27.9	10.5	M
	28.9	11.2	M

213937
RV Cygni

Mo.	Day	Est.	Obs.
3	13	7.7	M

222557
δ Cephei

Mo.	Day	Est.	Obs.
3	12.0	3.6	R
	14.0	4.2	R
	27.0	3.8	R
	20.0	3.4	R

230759
V Cassiop.

Mo.	Day	Est.	Obs.
3	4	8.0	Bu
	5	8.3	R
	8	8.2	R
	11	8.3	R
	13	8.5	R
	16	8.1	R
	16	7.6	Bu
	17	8.1	R
	17	8.0	M
	19	8.1	R

233335
ST Androm.

Mo.	Day	Est.	Obs.
3	4	11.0	Bu

235350
R Cassiop.

Mo.	Day	Est.	Obs.
3	4	9.2	Bu
	9	10.0	B
	19	10.2	B

No. of observations 1361; No. of stars observed 172; No. of observers 20.

Mr. McAteer, who contributed a fine list of 204 observations this month, is closely observing the 9.5 magnitude comparison star on the field of the variable 123459 RS Ursae Majoris, which he suspects of variability. Members can aid in determining the facts in this case by coöperating in the observation of this star.

Mr. C. B. Lindsley sent the Secretary fifteen splendidly executed blue prints of plotted curves collected in a neat pamphlet. Many of these have appeared in POPULAR ASTRONOMY, and reflect great credit on the draughtsman, beside attesting to the practical nature of the work we are engaged in. Mr. Lindsley and Mr. Pickering deserve our thanks for many blue prints of the charts contributed for distribution.

Special mention must be made of the large number of variables under observation during the past month, 172 in all. This is within four of the largest number we have observed in any one month.

Since October 1911 we have contributed the splendid total of 40,984 observations, which shows what coöperative work can accomplish in this practical line of observational work.

Mr. J. Halliday Crane, of Peterboro, Canada, and Mr. Edmund Mills of Jersey City, N. J., have kindly signified their intention of coöperating in the Nova search work we have instituted, and are observing zones 20 and 10 respectively. The only zones of the twenty-four, unclaimed, are zones 7, 8, 21, 22, 24. It is hoped that volunteers will soon apply for these.

Members kindly note a correction in the chart of 060450 X Aurigae. The 11.3 magnitude comparison star is 11.9 magnitude instead of 11.3 magnitude.

On the evening of March 30th a meeting of the eastern members of the Association was held at "The Lorraine" in New York City. Messrs. Bancroft, Barbour, Burbeck, Mills, Olcott, Pickering, and Putnam were present. The occasion was most enjoyable. Such meetings do much to stimulate interest in our work and serve to weld together an organization that means more to us each year of its existence. The secretary feels that we have in our association a power that in time is bound to promote the advance of astrophysical science, and the pleasant companionship of kindred interests that is now so well established among us, is a source of pleasure that, in itself, is worth all the efforts we have made to aid the cause.

The secretary, owing to a temporary absence from home, is obliged to resign his office for the time being. Nothing could be more indicative of the splendid esprit de corps that exists in our association than the ready response made to the call for a Secretary pro tem. Mr. A. B. Burbeck, of N. Abington, Mass., although a busy man, has agreed to act as Secretary temporarily, and members will kindly forward to him as early in the month as possible their lists for April, May, and June. To save Mr. Burbeck unnecessary trouble no letters acknowledging the receipt of lists will be sent. The July and subsequent reports may be sent to me as usual.

Mr. Burbeck deserves the thanks of the Association for the work he has undertaken, and our members will, I feel sure, support him and lighten his work in every possible way.

Mr. David B. Pickering, of 81 S. Burnett St., E. Orange, N. J., to whom we are indebted for the admirable arrangements for the recent meeting in New York, will be glad to supply any chart needs that may arise during the Secretary's absence.

The following members contributed to this report:—Messrs. Baldwin, Bancroft, Barbour, Bouton, Burbeck, Eaton, Harrell, Hay, Lacchini, Lindsley, Mach, McAteer, Mundt, Olcott, Pickering, Richter, Spinney, Vrooman, Miss Swartz and Miss Young.

WILLIAM TYLER OLCOTT,
Corresponding Sec'y.

Norwich, Conn.
Apr. 10, 1915.

Observations of Variable Stars.—The following star magnitudes have been estimated by me by Argelander's method. Except in the specified cases, a six-inch refractor has been used and magnitudes for comparison stars as given on Harvard charts. Where I have not had Harvard present values, I have used Hagen's.

Mar.	8	7 P. M.	*o* Ceti (Mira)	4.4 (naked eye)
	16	9 P. M.	W Orionis	6.6 (field glass)
	8	021024	R Arietis	9.3
	11	"	"	9.3
	11	023133	R Trianguli	10.3
	8	042209	R Tauri	invisible "p", 10.6 easily visible
	13	10h 042209	R Tauri	(12 inch) invisible; star of 11.8 mag. visible.
	18	11h 0422(9	"	invisible; 11.8 visible (12-inch)
	8	9h 042309	S Tauri	invisible; star of 10.6 visible
	13	10h "	"	" " " 11.8 " (12-inch)
	18	11h "	"	" " " 11.8 " (12-inch)
	2	8h *055305*	R Leporis	8.0 (doubtful on account of its color)
	15	7h 35m 05°104	V Orionis	10.1 (Hagen comp).
	8	10h 050953	R Aurigae	8.6
	12	13h "	"	8.5
Mar.	15	*052405*	S Orionis	not visible; 10.9 visible (Hagen)
Feb.	19	9h *053005*	T Orionis	9.4
Mar.	2	7h *053005*	T Orionis	9.6
	8	9h "	"	9.7
	11	7h "	"	9.9 (12 inch)
	13	10h:20 070109	V Can. Min.	11.1
	15	"	" "	9.5
	13	079310	R Can. Min.	10.4 (Hagen)
	15	"	" "	10.5 (Harvard)
	15	10h 074922	U Gemin.	fainter than 12.3; not visible
Mar.	18	11h "	"	13.7 (12-inch)
Feb.	18	10h:30 094211	R Leonis	6.7 (doubtful on account of color
Mar.	8	"	"	7.8 "
	19	"	"	7.3
	11	123160	T Urs. Maj.	9.2
Mar.	11	123961	S Urs. Maj.	11.3

MISS LEAH B. ALLEN.

Whitin Observatory, Wellesley College,
Wellesley, Mass. Mar. 25, 1915.

COMMUNICATIONS.

The Picture "Reflections".—I was very much interested in the beautiful picture in your No. 222 (February 1915), showing the moon, Venus and Halley's Comet. The drawing must be made in the early morning of May 6, 1910, or May 5, at about 22h Greenwich mean time, and gives the relative positions of the three bodies, as well as the comet's tail, very accurately. From Venus and the Moon the scale is found to be $1° = 2.22$ mm., from the comet and Venus $1° = 2.73$ mm., in the mean therefore $1° = 2.5$ mm. The moon's diameter being 5¾ mm or 2°.3, it appears that the draftsman has seen it about 4½ times too large. As he is likely to have seen the moon's height too large as well, I am not able to find out the exact place and hour of the observation, but Mr. Cooper will undoubtedly remember them and might inform your readers.

Of course a moon that would be seen in the top of a tree in the reflected image, should be drawn above the tree, as seen directly.

A. A. NIJLAND.
Professor of Astronomy.

Utrecht, Holland.
March 19, 1915.

Useless Figures.—In the *American Nautical Almanac* for 1915 the mean distance Earth to Sun is given as 149,499,935 kilometers. The calculation by which these figures were found, is correct, of course, and it might just as well have been continued to millimeters instead of stopping at the kilometers. But what is the use of printing a string of figures which we know are *not* correct. If we use as basis for our calculation Hayford's spheroid of 1909 instead of Clark's spheroid of 1866, which means an increase of 182 meters for the equator's radius, we have to add about 4000 kilometers to the figures given above. But of far greater influence than our uncertainty about the dimensions of the earth, is our limited knowledge of the value of the sun's mean parallax. If, for instance, we assume the parallax to be 8″.806 instead of 8″.80 the mean distance earth to sun diminishes by about 100,000 kilometers, or, in other words, for a change of one-thousandth of a second of arc in the value of the parallax the distance varies by about 17,000 kilometers. All that we can say according to our present knowledge, is that the mean distance earth to sun amounts to about 149.5 millions of kilometers. Any additional figures are useless and misleading.

CARL BOECKLEN.

Chicago.

The Section for Construction of Astronomical Instruments of the S. P. A.—The recent formation in the Society for Practical Astronomy of a Section for Construction of Astronomical Instruments was announced by the Editor in the current (March) issue of this journal (page 188). Thinking that an outline of the proposed subjects of such a unique body might interest amateur astronomers in general, I submit herewith a brief description of the Section and its aims.

The Instrument Section of the S. P. A. was officially established on January 30 of this year, and was placed under the direction of Professor M. Thomas Fullan, B. S., M. E., of the department of machine design and drawing of the Alabama Polytechnic Institute, at Auburn, Ala. Professor Fullan has had wide experience in the construction of reflecting telescopes and other astronomical instruments, and has, for some time past, been engaged in corresponding with amateur constructors all over the world. From the benefit of his ripe experience, he is therefore peculiarly adapted to take charge of this new but important department of the society, and the Council consider themselves very fortunate in securing his services for this occupation. Surely the subject of instrument construction is as truly a branch of practical astronomy as is any kind of observational work, and indeed a most essential one, for we must have instruments before we can make our observations. It therefore comes most appropriately within the scope of a Society for Practical Astronomy.

As the editor has remarked, the purpose of the Section is to aid amateurs and beginners in the construction of their own telescopes and accessories. But Professor Fullan has wisely stated that "While telescopes, particularly reflectors, will be the main work of the Section, the accessories of photographic cameras, spectroscopes, eyepieces, sidereal clocks, and other apparatus, are quite as well within the range of the average amateur worker as is the telescope itself." Hence the name of the Section has purposely been made as inclusive as possible.

In the January and February, 1915, number of the *Monthly Register* of the S. P. A., there was published an extract from the Director's preliminary report to the Council. This outlines the proposed work of the Section. Although I cannot give all the substance of that communication here, I will nevertheless give the essentials in the following excerpts:—

"The Section for Construction of Astronomical Instruments of the Society for Practical Astronomy should have for its purpose the fostering of telescope and accessory construction, and should make every effort to locate eligible members for the Society. It should also keep in touch with those members who have joined for the purpose of building their own instruments, until finally with the completed instrument they may be eligible to join one of the other Sections. As the first Director of this new Section, I propose to follow the genteral policy as above expressed, and will make every effort to locate eligible members, and, where possible, to keep in touch with them until they have accomplished the end for which they joined my Section.

"I propose to pursue one or more methods of campaign for furthering this work, of which are the following:

" (3) To get into communication with prospective members from abroad in England, Scotland, Ireland, France, Germany, South Africa, India, Australia, New Zealand, and Canada. Of course, just now the unsettled conditions in Europe will not warrant any effort of making a campaign along scientific lines, but when these conditions have ameliorated, this plan will be attempted.

" (4) I have in hand a large amount of information on astronomical instrument construction which has been collected for the purpose of publishing a rather complete work on the reflecting telescope, in fact an amateur constructor's *vade mecum*. I hope in a short time to put this into book form. However, before this is accomplished, I will publish it in parts so that it can be used as a textbook with the members of my section. Just at present I hope to get the first portion of it in mimeograph form before the first impression is made on the parts. A small charge will be made for the sheets, just sufficient to cover the cost of getting them out."

As seen from the foregoing, the Section proposes to offer what will be essentially a correspondence course on the subjects it embraces. It ought therefore to be of great value to all persons desirous of learning how to make their own instruments. If any amateurs are interested in this important work, and wish to register in the section, we shall be pleased to receive them as members into the S. P. A., and enroll them in the Instrument Section. Correspondence may be addressed either to Professor Fullan, the Director of the Section, or to the President of the Society.

FREDERICK C. LEONARD,
President of the S.P.A.

1338 Madison Park, Chicago, Ill.,
1915 March 23.

GENERAL NOTES.

Professor R. G. Aitken, of the Lick Observatory, lectured before the Astronomical Society of the Pacific in the Chabot Observatory, March 27 on "Globular Star Clusters." (*Science* April 16, 1915.)

Mr. J. Evershed, director of the Solar Physics Observatory, Kodaikanal, India, was among the fifteen candidates selected by the council for election into the Royal Society, London.

Dr. H. D. Curtis, of the Lick Observatory, lectured before the faculty Science Association of Stanford University, on March 24, on "Some Recent Theories and Developments in Cosmogony." (*Science* April 16, 1915).

Lady Huggins, widow of Sir William Huggins, the distinguished astronomer, and known for her scientific work, died at her home in London, on March 25. Lady Huggins was born in Dublin and married Sir William Huggins in 1875. She was joint author with him of many scientific papers, and of an Atlas of Representative Stellar Spectra. She was the author of a monograph on the Astrolabe; of articles in the Encyclopædia Britannica, and of papers in astronomical and archæological journals. (*Science* April 2, 1915).

Dr. John A. Brashear, the world-famous telescope maker of Pittsburgh, Pa., who was recently elected President of the American Society of Mechanical Engineers, is expected to address the Providence (R. I.) Branch of that Society at the occasion of their annual meeting and banquet, which will take place at the Churchill House, Providence, on Wednesday evening, April 28. The subject of Dr. Brashear's lecture is to be "The Great Telescopes of the World and Their Achievements." A very enjoyable and instructive evening is assured.

It was feared at one time that an attack of illness would prevent Dr. Brashear from lecturing before the Society, but his recovery fortunately occurred in time so that he was not obliged to cancel the engagement.

The banquet will come first on the program, after which it will be declared an open meeting, and ladies will be admitted to listen to the distinguished lecturer.

Dr. Brashear is expected to speak at Brown University on Thursday morning. He will stop off in Providence on his way to West Point, where he has an engagement to address the students on the subject of astronomy, as they are expected to "brush up" their knowledge of that science before the graduating exercises take place.

The Princeton University Observatory has received from Mr. Archibald D. Russell, of New York, a gift of the sum necessary for the carrying on for five years of its share of the work described in Professor Pickering's summary of the present needs of the astronomical research, given in *Science* January 15, 1915.

Chicago Astronomical Society Reports.—There are available for distribution at the Dearborn Observatory several sets of reports of the Chicago Astronomical Society. These reports contain records of observations of the early years at the Dearborn Observatory. Such observatories as do not have a set of these reports may have them on application.

Observations of Saturn at the Lowell Observatory have revealed no less than seven divisions in ring B, the middle one. Measures of the different parts of the rings indicate that these divisions have a theoretical importance.

Measures of the System of Saturn.—The *Lowell Observatory Bulletin* No. 66 contains the results of recent measures of the Ball Rings and satellites of Saturn by Percival Lowell, with the 24-inch refractor. They were taken with the purpose of determining the effect of irradiation. The following are some of the mean results:

	At Mean Distance	
	Freed from Effect of Irradiation	Irradiation large
	"	"
Diameter of Ball	17.26	17.68
Breadth of B ring, Inner edge	26.33	...
Outer edge	33.64	34.02
Breadth of A ring, Outer edge	39.71	40.03
	"	
Width of Cassini Division	0.49	
Diameter of Titan	0.568	
Observed magnitude of Titan	9.60	
Mass " "	$\frac{1}{4700}$ of Saturn's mass	
Albedo " "	0.177	
Density " "	0.691 of the earth's density.	

Measures of the Diameter of Neptune made during the last months at the Lowell Observatory give for that diameter 2".25 ± at the planet's mean distance. This means a smaller volume and a greater mean density for this body than is given in most textbooks.

Orbit of the Ninth Satellite of Jupiter.—The *Lick Observatory Bulletin*, No. 265, gives an account of the discovery, last summer, of the Ninth Satellite of Jupiter by Mr. Seth B. Nicholson. Reproductions are given of parts of three photographs showing both the eighth and ninth satellites. Positions of the ninth satellite have been measured upon eight plates taken July 21, 22, 23, 24, 27 31, August 23, September 20 and September 21, and from the first six of these Mr. Nicholson has calculated the orbit, finding it to be an ellipse around Jupiter, the period of revolution being 3.125 years. The elements are somewhat uncertain and observations after a year or more has elapsed will be necessary to determine the orbit with the requisite accuracy. The approximate elements are as follows

Epoch and Osculation = 1914 July 27.8817 Gr. M. T.

$M_0 = 49° 28'$
$\omega = 71 10$
$\Omega = 309 23$ } 1914.0
$i = 157 51$
$e = 0.1630$
$\mu = 0°.3154$
$P = 3.125$ yrs.
$\log a = 9.3232$

The motion, like that of the eighth satellite, is retrograde.

Orbits of Spectroscopic Binaries.—Orbits of three spectroscopic binaries, ϵ *Volantis*, ν *Centauri*, and υ *Sagittarii* by R. S. Sanford and R. E. Wilson are given in the Lick Observatory Bulletin No. 267.

Star	ϵ *Volantis*	ν *Centauri*	υ *Sagittarii*
Computer	Sanford	Wilson	Wilson
P	14.16833 days	2.62516 days	137.930
e	0.00	0.00	0.087 ± 0.016
T	J.D. 2419453.562 ± 0.009	2420301.39 ± 0.015	2419648.72 ± 1.15 days
K	66.67 ± 0.25 km.	20.63 ± 0.77 km.	48.15 km.
V_0	+ 9.68 ± 0.19 km.	+ 9.05 ± 0.54 km.	+ 12.1 km.
ω	...	...	28°.6 ± 2°.8
$a \sin i$	12,999,400 km.	745,000 km.	91,010,000 km.
$\frac{m_1^3 \sin^3 i}{(m+m_1)^2}$	0.437 ⊙	0.00239 ⊙	1.582 ⊙

Correction to "Meteorology of the Moon".—We are sorry that our engraver misunderstood instructions on Figure 9 in Professor W. H. Pickering's article on the "Meteorology of the the Moon" in the March number of POPULAR ASTRONOMY, page 132. The cut should have been reversed in color, white for black. Of course most of our readers would understand that the picture as printed was a negative, the black spots representing white snow.

New Large Telescope for Argentina.—From the Cleveland *Plain Dealer* of March 25, we learn that the Warner & Swasey Co. has been awarded the contract for the construction of a 60-inch reflecting telescope for the National Observatory at Cordoba, Argentine Republic. The director of this observatory is Professor Charles D. Perrine, who was formerly secretary of the Lick Observatory.

The mirror for the new telescope is to be made from a disk of glass cast in France, sixty-one inches in diameter, eight inches thick and weighing one ton. The great tube, twenty-seven feet long and six feet in diameter, with its accessories, will weigh more than fourteen tons. This will be the largest telescope in use in the southern hemisphere, for a time at least.

The Highest and Lowest Temperatures in the Atmosphere.—An editorial in *The Scientific American* for January 9, 1915 gives the following as the extreme temperatures, actually recorded by trustworthy observers, of the atmosphere near the surface of the earth:

Highest 127°.4 Fahrenheit at Ouargla, Algerian Sahara
Lowest —97 .6 " " Verkhoyansk, Siberia

Higher temperatures have been recorded by travelers, but it is doubtful whether the thermometers in these cases were properly shaded from the direct rays of the sun. In direct sunlight the thermometer may record much higher readings. Lower temperatures have been recorded in the air at various altitudes above the surface of the earth. The "record" up to date is 133° below zero Fahrenheit, obtained by means of a self-registering thermometer attached to a sounding balloon, at a height of about ten miles above the island of Java, only a few degrees of latitude from the equator.

The Meaning of the Three Star Streams.—At the December meeting of the Royal Astronomical Society (England) Professor H. H. Turner presented a paper on the meaning of the so-called Third Star Stream Drift O". His remarks before the society put the matter in a very popular way, so that we will quote the remarks almost in full. He said: "This note is the outcome of a very hasty perusal of Professor Eddington's fascinating book on Stellar Movements. At the end he puts a series of questions summing up the present situation. One of these questions I have previously attempted to answer. This note is an attempt to answer another. The first question is as to the meaning of the two star-streams. My explanation is that the whole mass of the sidereal star system must exercise a gravitional force on each member of the system, and they will move under this force in elongated orbits. One star-stream is the aggregate of all those stars moving away from the centre, and the other of all those moving towards it. The second question is, what is the meaning of the third stream? My former answer might seem to leave no room for a third stream; but, on the contrary, it actually suggests an answer. If the stars move to and fro, there is a considerable time when they are

moving neither to nor fro, the time depending upon the law of attraction, which is probably between the direct distance law (corresponding to a spherical system) and the inverse square law (corresponding to a concentration of the mass at the centre.) In the case of the latter law, we are familiar with the long period of time spent by comets near their turning points. Stream O is, then, the aggregate of all stars at the end of their orbits, and it is well known that this stream is at rest in space. There are two characteristics worth noting: this stream contains many distant stars, and this is what the explanation would lead one to expect; also it contains a large number of stars of the Orion type. Is this not a real physical connection, depending upon the origin of all those stars? The Orion stars were formed at the same moment, and have now arrived at the same time at the pause position; but here we are in more speculative regions."

The Reaction of the Planets upon the Sun.—In the Smithsonian Report for 1913 is given a translation of a lecture by P. Puiseux, astronomer at the Paris Observatory, delivered at the *Conservatoire des Arts et Métiers*, February 23, 1913. The subject of the lecture was "The reaction of the planets upon the sun," and the speaker after an introductory discussion of the general phenomena of the sun, took up the question of the possible relation between the sunspot cycle and the positions of the planets.

Considering the periods and masses of the planets, the most favorable planet to study first would appear to be Jupiter, but the sun-spot cycle is 11.13 years while the period of Jupiter is 11.86 years, a difference of eight months which in the course of nine cycles would change a complete coincidence into absolute discordance. The result is no more favorable in the case of the other planets, none of the periods fitting into the 11 year cycle.

On the other hand, when the question is considered whether the planets may not produce tidal waves upon the extremely mobile surface of the sun, moving over it with the corresponding synodical rotation period and capable of producing visible disturbances, apparently reliable favorable evidence is found in the case of the earth, Mercury, Venus and Jupiter. The deforming factor or tide-producing factor varies as the product of the mass by the inverse cube of the distance. The following are the deforming factors for the different planets expressed in terms of the earth's factor as unity:

Mercury	1.04	Jupiter	2.20
Venus	2.09	Saturn	0.106
Earth	1.00	Uranus	0.019
Mars	0.03	Neptune	0.001

It at once appears that Jupiter and Venus have the greatest disturbing power. Mercury and Earth coming next in order, the effect of the other planets being much less.

As the earth is the most favorably situated that is considered first. We can count all the spots which appear on the hemisphere of the sun nearest us. If the earth has no influence upon the sun, the spots on the eastern and western halves of the disk should, in the long run, be equal in number. If the presence of the earth above the horizon of a region of the sun's surface favors the development of a spot there, such action will require time to make its results manifest and so more spots should appear on the western half than on the eastern half of the disk. If the presence of the earth above the horizon is unfavorable to the existence of spots, the number of spots will be less on the western half of the disk than on the eastern.

From Mrs. Maunder's researches on the photographs of the sun taken in the English observatories in the interval 1889 to 1901, it is found that during that cycle both the total areas and the number of spots were greater on the eastern half than on the western half of the disk, i. e., the earth's influence was to cause spots to disappear. The same result was obtained from both the northern and southern hemispheres.

The astronomers at the Kew observatory in 1872 obtained exactly the opposite result, and also found that spotted areas tend to increase opposite to Mercury and Venus. Jupiter, upon which the greatest hope was placed, gave no definite results. The data at the disposal of the Kew observers was comparatively meager and Mrs. Maunder's results should be given greater weight.

In 1911 Professor A. Schuster studied the results from the Greenwich photographs for the years 1874 to 1909. He considered only the births of spots which lasted over the interval between the plates of two successive days, excluding as more subject to error those whose births occurred within 30° in longitude of the eastern edge of the sun's disk. There remained 4,271 spots to consider. For each planet the sun was divided into 12 equivalent vertical zones, the solar meridian passing through the planet forming the boundary between zones 6 and 7 on the hemisphere toward the planet and between 12 and 1 on the farther side. The number of spots seen for the first time in each zone was counted and used to form a plot having as abscissæ the zone numbers. The results are somewhat irregular. When the spots counted when the earth is east and west of the meridian are considered separately each of the planets Mercury, Jupiter and Venus seems to produce a minimum of spots just where the other may produce a maximum. When the above distinction is not made the results seem more accordant. For all there is a minimum upon zone three, where the planet is just rising, and a maximum on zone eight, which has already passed the meridian. Schuster considers that the similarity of march of the three curves for divisions 3 and 8 is sufficiently characteristic for rendering very probable the reality of a planetary influence. When two or more planets were in conjunction no marked difference was evident. Schuster thinks that a planet may have merely an exciting action, effective only in putting into play a force already existing in the sun, so that a second planet on conjunction might not have any additional effect.

Mr. F. J. M. Stratton also in 1911 studied the disappearances of spots as well as the appearances, using the same series of the Greenwich photographs as Schuster used. He considered only Jupiter and Venus and divided the sun's surface into 24 equal zones instead of 12. The plots were very irregular. Generally there was no similarity in their contour, even for the same planet, between the two hemispheres; neither was there between the same hemispheres for different planets. There is one single coincidence, perhaps, which seems not due to chance. There is a maximum of ephemeral spots noted in the zones the meridians of which either Jupiter or Venus had passed three hours previously.

On the whole the impression made by Professor Puiseux's address, although he speaks quite optimistically, is that the evidence of planetary influence upon the sun is extremely uncertain.

Actual Time of Signals from the U.S. Naval Observatory, March, 1915.

Day	Time of signals Noon				Time of signals 10:00 p.m.				
	h	m	s		h	m	s		
1	12	0	0.02	+.02	10	0	0.03	+.03	
2	12	0	0.03	+.03	10	0	0.04	+.04	
3	12	0	0.04	+.04	10	0	0.05	+.05	
4	12	0	0.01	+.01	10	0	0.03	+.03	
5	12	0	0.00	.00	9	59	59.93	−.07	
6	11	59	59.92	−.08	9	59	59.90	−.10	
7	11	59	59.90	−.10	9	59	59.89	−.11	Sunday
8	11	59	59.89	−.11	9	59	59.86	−.14	
9	11	59	59.88	−.12	10	0	0.01	+.01	
10	11	59	59.98	−.02	9	59	59.99	−.01	
11	12	0	0.01	+.01	9	59	59.99	−.01	
12	11	59	59.99	−.01	10	0	00.4	+.04	
13	12	0	0.00	.00	10	0	0.02	+.02	
14	12	0	0.01	+.01	10	0	0.00	.00	Sunday
15	11	59	59.98	−.02	9	59	59.95	−.05	
16	11	59	59.96	−.04	9	59	59.97	−.03	
17	11	59	59.95	−.05	9	59	59.96	−.04	
18	11	59	59.93	−.07	9	59	59.92	−.08	
19	11	59	59.93	−.07	9	59	59.93	−.07	
20	12	0	0.03	+.03	10	0	0.03	+.03	
21	12	0	0.02	+.02	10	0	0.03	+.03	Sunday
22	12	0	0.03	+.03	10	0	0.05	+.05	
23	12	0	0.03	+.03	10	0	0.01	+.01	
24	12	0	0.02	+.02	10	0	0.01	+.01	
25	12	0	0.01	+.01	10	0	0.02	+.02	
26	12	0	0.12	+.12	10	0	0.05	+.05	
27	12	0	0.01	+.01	10	0	0.05	+.05	
28	12	0	0.03	+.03	10	0	0.04	+.04	Sunday
29	12	0	0.06	+.06	10	0	0.04	+.04	
30	12	0	0.04	+.04	10	0	0.04	+.04	
31	12	0	0.05	+.05	9	59	59.96	−.04	

(+) slow (−) fast

Maximum error: Mar. 8 −.14.

To get a very close approximation to the signals received by radio from Arlington add .08 sec. from Key West add .33 sec.

J. A. HOOGEWERFF,
Captain U.S. Navy
Superintendent.

U.S. Naval Observatory,
Washington, D. C.
April 6, 1915.

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Baxandall, F. E., I. Comparison of the spectra of Rigelian, Crucian and Alnitamian stars. II, A discussion of the line spectrum of α Orionis. III The spectrum of γ Cassiopeiæ. Solar Physics Committee, London, 1914.

Lockyer. Sir Norman, Areas of calcium, Floculi on spectroheliograms, 1906.1908, solar Physics committee, London, 1914.

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"EMIGRAVIT".

[Professor Winslow Upton,.....Died Jan. 8, 1914.]

Orion walks the southern sky;
Great Sirius follows close behind;
The souls of those who are to die
Go forth upon the wind.

Though the fair moon her face unveils
To Saturn, shining gloriously;
Though ruddy Mars at sunrise pales,
He is not here to see.

The Northern Cross, with Vega near,
Sinks upright in the western wave,
But he, to whom all stars were dear,
Sleeps soundly in the grave,

No more to rise ere morning light
Had veined the east with rose and gold,
To scan the starry deeps of night,
New wonders to behold.

The strong and kindly sympathy,
The steady faith, th'unfaltering trust,
Receptive brain and earnest eye,—
Must these resolve to dust?

Death cannot harm the steadfast soul;
It bursts its earthly prison bars
To wander free from pole to pole,
And sojourn with the stars.

He haply, in some other sphere,
Some brighter world beyond our ken,
Completes the task relinquished here,
In ways unknown to men.

From world to world his journeys are;
Congenial themes his thoughts employ,
Where morning star and evening star
Together sing for joy.

He comprehends each cosmic law
Which binds the whirling orbs of space;
He through a glass who darkly saw,
Sees clearly, face to face.

V. E. ATWELL.

Jan. 8, 1914.